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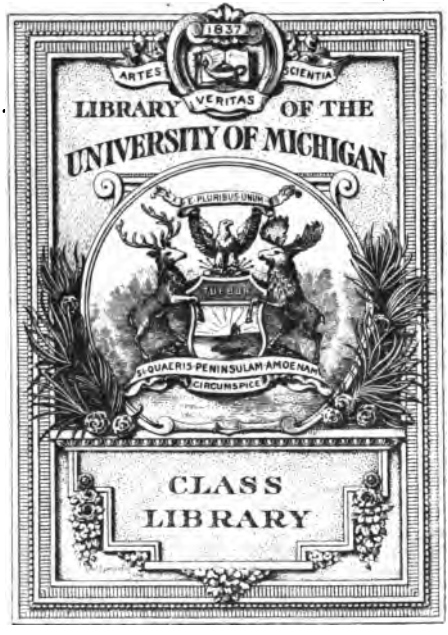

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Yours Truly W. J. Gottra

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Some Facts
About
Treating Railroad Ties

By

W. F. GOLTRA

PRESIDENT, THE W. F. GOLTRA TIE CO.

Formerly General Tie Agent of the
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West of Buffalo

CLEVELAND, OHIO

1912

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PREFACE.

The purpose of this book is to furnish some information as to some methods employed in this country for treating railroad cross ties, and to suggest some improvements.

It has been my aim to state the facts correctly, without fear or favor, and trust that this work will prove of some value to those interested in wood preservation, and throw some light on this subject. Timber treating is comparatively in its infancy in this country and some of the methods and practices can be materially improved. Development and improvement in the art of timber treating has been retarded by promoters of bogus processes and by the suppression of information and ideas that are opposed to them.

The most demoralizing and dangerous elements to meritorious wood preserving in existence today are concerns which have foisted their worthless processes for treating railroad ties on some of the railroads of this country. I cannot patiently accept the present situation or allow their unwarranted assumptions to go unchallenged.

The absurdity of the conclusions and the industry with which they have been pressed upon the railway managers, while being made a source of profit to the promoters, makes it important that their nature be understood. The value of any treatment can be judged only by a careful record of conditions from year to year. Very little record of the efficiency of the various processes is found and even this, in some cases, is discredited by some writers who possess but little knowledge of the facts and seem to be in too many cases impelled by self-seeking motives and too often accompanied by little or no practical knowledge. How is it possible to determine the facts and pass upon the efficiency of a new process without an honest and accurate inspection covering many years? Any process, before it can be proved of value as a treatment, must have the "test of time" and its success or efficiency cannot be predicated upon any theory. The ambiguity of arguments and the ease with which deception may arise has confused and deluded many people who possess only a general knowledge of timber treating. During the past decade a new element, a new phase of ethics at least, has been introduced into the business it cannot be called business method—by which the business is being disturbed, for a time at least. The sum of acquired knowledge and the experience of many years is thrown aside scornfully and has been replaced by untried methods having absolutely no record as to their value as preservative treatment. Not only this, but they are being forced upon the railroad world to the exclusion of sane and tried methods long known to have been successful. It is claimed by this new propaganda that this is essence of wisdom, that it be universally accepted, settling every doubt in the mind of every railroad manager so that he need know nothing more about it, except to wrap himself in an abounding faith and

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allow his ties to be superficially treated or well blacked, after elaborately piling them in yards for many months until, through decay, checking and splitting, their usefulness is more or less impaired.

The crude practice in vogue of seasoning ties can be materially improved. Air seasoning alone is slow and inefficient. It takes too much time to meet modern requirements and it requires a much larger area for stacking the ties and other material than when they are artificially seasoned. It locks up a considerable amount of capital, so that artificial processes of seasoning are to be preferred. The stocks of railroad ties and other material in many cases could be reduced down to one-half or one-third of what is now carried on hand if the timber was given a preliminary steaming before the air drying period and then complete the drying in ovens or kilns. Furthermore artificial seasoning or drying puts the ties in a much better condition for the reception of antiseptics, consequently a much better penetration and dissemination of the chemicals would be obtained.

Machining of ties prior to impregnation is another important factor for prolonging the life of ties and should not be neglected.

The sorting of ties into many groups, such as species, ratio of heart wood and sap wood, density, moisture content, and many other divisions, with a view of obtaining uniform absorption, has proved to be impractical and useless.

The use of creosote oil exclusively for treating ties has been found to be expensive and extravagant in this country and a great economy can be effected by the use of less costly preservatives in combination, with or without creosote oil.

This treatise is the result of many years of painstaking study and research, coupled with long experience in the purchase and treatment of railroad cross ties. During the development of the process and methods described in this book and in the designing of the apparatus and facilities employed to accomplish the desired results, I was largely assisted by many persons who are specialists in their line of work, thus insuring the practicability of the arrangement and the efficiency of a plant as here proposed.

In this book I have only considered and discussed the financial side or economy of treated ties. There is another side of the question which is more important to the country at large than the loss of several millions of dollars annually to the railroads, on account of improper preparation and treatment of cross ties, and that is the safety of the traveling public. It makes me shudder to contemplate what is very likely to happen before long, where improperly treated ties are being laid in the tracks. The public has no conception of the danger to which they are being exposed. Hundreds of thousands of Beech, Maple, Elm, Gum and other species of woods are now used instead of White Oak, for cross ties.

When properly seasoned, prepared and treated they are as safe as and will outlast White Oak ties, but untreated they will rot in three or four years. To obtain thorough treatment they must be thoroughly seasoned, otherwise the treatment will be only superficial and decay in the interior of the ties will progress more rapidly than if not treated at all.

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The superficial coating preserves the exterior of the ties and to outward appearance they seem to be all right, but some day without any warning the shell will crush in, the spikes give way, the track will spread and an appalling disaster will be the consequence. The railroads may be able to withstand the loss of millions of dollars to gratify the insatiable greed of some men, but their money will not repair the injuries or bring back to life those maimed, crippled or killed in accidents, occasioned by defective track.

I am under great obligation to the technical press in general and to the Railway and Engineering Review in particular for the interest they have taken in and for the large amount of space they have devoted towards the publication of matters pertaining to wood preservation. Through the medium of the press the people are becoming enlightened on this important subject. Let us convince people of the merits of legitimate work by proper methods. Let us profit by the wisdom and experience afforded by the past, keep pace with improved methods of the present and continue to hold our place amongst worthy industries in America, which leads all nations in the art and science of timber preservation.

W. F. GOLTRA.

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PART I

Some of the Present Methods
Employed for
Treating Ties and Timbers

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INTRODUCTORY.

The perishable nature of timber, especially when placed in situations where there is an excess of moisture in the surroundings, has led to many experiments, with the object in view of discovering a process of treating it with salts or oil that would preserve it from decay.

Dry rot, sometimes called "sap rot," the most formidable disease to which timber is subject, is commonly attributed to a combination of the acids found in the saps with the oxygen found in the air, which produces fermentation, followed by decomposition. Green timber, placed in damp situations, with partial ventilation, will soon show signs of dry rot. Beams and railroad ties, which presented the appearance of being sound on the outside, have been found completely decayed on the inside. Railroad cross ties have broken to pieces when unloaded from cars on account of the interior being completely dry rotted. The shell of these timbers remained sound, because it had become seasoned and relieved of the saps. Dry rot is a disease, apparently infectious, which occasions the destruction of wood fibre and eventually reduces it to a mass of dry dust.

Wet rot (as distinguished from dry rot) is considered to be occasioned by alternate exposure to moisture and dryness; the result of exposure of wood to the repeated changes of climatic conditions, beginning at the surface of the timber and working inward. Piles or other timbers placed in salt or fresh water will show signs of wet rot at the water line before it attacks other parts. Posts and telegraph poles set in the ground begin to rot at the ground line.

In both diseases a kind of spontaneous combustion or decomposition goes on in the wood. Water, carbonic acid gas and probably carburetted hydrogen are evolved and a pulverulent substance, or humus, remain. Though the growth of fungi undoubtedly accelerates the progress of dry rot, it would seem that the true origin of the disease is the incipient decomposition of the saps and juices in the wood and that by virtue of this decomposition the fungi obtain a nidus for their growth. Among the early investigators of the subject of preserving timber may be mentioned Johann Glauber, the famous chemist of Carlstadt, Germany, who, in 1657, experimented with vegetable tar and pyroligenous acid, the wood having been first carbonized by the action of fire, then covered with a coating of tar and immersed in the acid. Since this period many processes have been tried, but most have not survived, either through cost of material or difficulties in their application.

It is a difficult problem to treat timber in large quantities and meet with reasonable success. The condition of the timber that is to be treated should always be considered. It should be sound; it should be properly seasoned; it should not be treated in a wet or frozen state

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and it is advisable to shape the timber to the form in which it is to remain. In the case of railroad ties they should be adzed and bored before treatment is applied.

The method of impregnating should also be carefully considered. In the case of railroad ties the injection of the fluid should be carried to refusal, after they have been put in the most receptive condition; and the oil or chemicals should be effective and of lasting quality.

Some processes, particularly those which attempt to treat railroad ties with small doses of creosote oil, require the separation of ties into many groups for treatment. In the following pages I will endeavor to show that it is impractical and unnecessary to sort ties into many groups for treatment.

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ADVANCE COPY OF PAPER TO BE PRESENTED AT THE SEVENTH ANNUAL MEETING TO BE HELD IN CHICAGO JANUARY 17, 18 and 19, 1911.

This paper is printed in advance for the convenience of members in their discussion of the subject; also to enable it to be presented before the Association in abstract if time prevents it being read in full.

ON THE FEASIBILITY OF GROUPING TIMBERS FOR TREATMENT.

By W. F. GOLTRA,
President, The W. F. Goltra Tie Co., Cleveland, Ohio.

It is held by some engineers that in order to secure the best results from treatment, by any process, that it is necessary to separate ties into groups or classes before placing them in the retorts, so that each tie will receive, as nearly as possible, the same quantity of creosote oil, consequently result in a more uniform penetration and absorption, than would otherwise be obtained if the ties were not separated.

There are a good many factors entering into the problem and to give due consideration to any or all of them would require the separation of the ties in a good many groups. To do this necessarily involves labor and expense and unless the advantage due to greater uniformity of treatment more than offsets the expenditure of time and money to separate the ties into groups, it would be unprofitable to have a system of grouping.

By "uniform treatment" it is generally understood to mean that each tie or cubic foot of timber in any charge shall contain, after treatment, about the same **quantity** of creosote oil. Some specifications for treating limits the quantity of creosote oil at so many gallons per tie, or so many pounds per cubic foot of timber, and in order to leave as nearly as possible the same quantity of oil in each tie, or cubic foot of timber, resort is made to grouping of the ties or timber for treatment. Whenever the quantity of oil or preservative is not limited and the material is treated to **refusal**, grouping of ties and timbers is not so essential, because when the material has absorbed **all** the preservative that can be put into it, it cannot imbibe any more. But whenever the quantity of oil is limited in the specifications the operation usually ceases before the material is completely treated and the variation in quantity of oil in each tie or cubic foot of timber is sometimes very large. To cite an example: Last year the writer conducted a test at a certain treating plant and weighed 1,020 ties separately, before and after treatment. It was found that the quantity of creosote oil left in each tie ranged from two (2) pounds to sixty (60) pounds. Fifty-two per cent of the ties had less than 21¾ pounds or 2½ gallons per tie; 48 per cent had more than these quantities. The average was 21.72 pounds or nearly 2½ gallons per tie, which was the quantity of oil that the contractors were required to put in the ties under the terms of their contract.

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Inasmuch as no two ties or two pieces of lumber are exactly alike in respect to moisture content, wood structure, proportion of heart wood and sap wood, and in many other respects, it is quite impossible to attain uniform treatment as generally understood, by grouping of the ties and timbers, and the variation is found to be considerable, regardless whether the ties or timbers are grouped or not, for treatment.

The main factors that enter into the problem may be stated as follows:

(1) Moisture Content or Degree of Seasoning.

(2) Physical Structure of Wood in relation to its Penetrability by Preservatives.

(3) Percentage of Heart Wood and Sap Wood.

These are some of the main factors entering into the problem of grouping or separating the woods for treatment. Mention might be made of several others of lesser importance. Let us consider the main factors only.

(1) Moisture Content or Degree of Seasoning, is perhaps the most important factor under consideration. It is a well known fact that wood must be dry before it can be treated, as green wood resists the entrance of the preservative. Therefore upon the extent of dryness of the wood depends in a great measure the quantity of preservative that will be absorbed.

The green, unseasoned timber of **hardwoods** contains on the average water to the extent of about 42 per cent of its total weight; that of the **softwood,** about 52 per cent, and that of **pine,** about 57 per cent. Hence, green wood in general may be said to contain water to the extent, in round numbers, of about half of its weight, but the actual quantity varies with the kind of tree, season of the year, part of the tree, soil and locality, etc. It is never pure water, but here, too, the kind and quantity of sap substance it contains varies also according to the tree, season, soil, etc. This water, contained throughout the tissues and in the intercellular spaces, begins to diminish in quantity by evaporation into the air after the tree is felled, and this evaporation goes on, at a gradual, diminishing rate, until a condition is reached when there is more or less equilibrium between the tension of the atmosphere and power of evaporating the water still contained in the wood. When this condition is attained the wood is said to be **seasoned** or **air-dried,** but it still contains a considerable quantity of water, varying according to the nature of the wooded tissue and other substances within the wood and their power of retaining water. After the log is manufactured into ties or lumber it loses its moisture quite rapidly at first. From experiments made with beech ties which were cut immediately after the trees were felled, it was found that they contained an average of 45 per cent of their weight of moisture. They were then placed on supports, under shelter, to season. At the end of five months' seasoning (from May to October) the ties were weighed and it was found that they still contained 21 per cent of

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moisture. It was also found that the wood seasoned very slowly after the first six months, and that after six years of seasoning, under shelter, the beech wood still contained from 10 to 12 per cent of moisture. From the point of view of practicable seasoning of ties, it is scarcely possible, without kiln drying, to lower the moisture much below 20 per cent. The various kinds of woods season at various rates. Some woods dry more slowly than others. Again, some woods contain more moisture at the beginning, so that after air-seasoning for several months the moisture content in the various kinds of woods is considerable and not definitely known and on this account it is difficult to say when the preservation process can best be undertaken. This refers to heart wood, not to sap wood, which loses its water very rapidly.

On some roads it is the practice of shipping ties to a central plant for treatment. These ties are in all stages of seasoning. Some with one month's seasoning, some two, some three and upwards.

The writer has seen contracts made between railroad companies and treating companies that required the ties to be shipped in the "order of their cutting," so that all of the ties in any car would be equally seasoned. Anyone who has practical experience knows very well that it is impossible to deliver ties at the treating plant in the order of their cutting. They are manufactured at all times during the year along the railroad lines or along the rivers and transported in various ways, by rail, by barges and rafts. Cross ties are not made expressly for any railroad, but are bought on the market. Some ties may have been manufactured for several months before the producer can find a market for them and there are conditions when these ties which are seasoned have to be loaded and shipped with ties that were manufactured several months later. Furthermore, the shippers have to secure cars and barges to transport the ties and they cannot control the conditions. It is not always possible to separate the ties into groups according to their different degree of seasoning, as they are loaded on cars or barges, as it is absolutely necessary to fill them to their full capacity, and ties of different degree of seasoning must necessarily be loaded together. For these and other reasons it is manifestly impossible to separate the ties into groups according to their degree of seasoning, as they are loaded into cars; therefore it is impossible to ship them to the plant in the order of their cutting. The writer has observed that when ties reach the treating plant they are unloaded and piled together regardless of their degree of seasoning. It is a common practice to consider all ties in any car as being of equal dryness. This is not correct in all cases, as there may be some ties that were cut one month, two months, three months and upwards. It would be useless to attempt to separate the ties according to their different degree of seasoning at the plant, because the men who unload the ties are not competent to determine that, consequently could not separate them into groups intelligently.

The manner of piling ties in the yard also affects the rate of seasoning. Ties that are piled together dry slower than those piled more openly. Again ties on top of the piles dry faster than those in the body

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of the pile. Some woods dry faster than others, but in going through some yards the writer observed that they are all usually piled in the same manner.

From the foregoing it is evident that ties and timbers placed in the retorts must contain varying amounts of moisture, that is, some are drier than others and the exact amount of moisture contained in each tie is unknown. All we know is that the material has had an average seasoning. Some pieces may be under-seasoned, while others are over-seasoned.

The theory of separating woods according to their moisture content so that they will absorb the proper quantity of preservative is a nice theory, but it does not work out in practice.

(2) PHYSICAL STRUCTURE OF WOOD IN RELATION TO ITS PENETRABILITY BY PRESERVATIVE FLUID.

The group of physical properties of wood now to be considered and on which the penetrability of fluids is directly dependent are: (1) Anatomical structure. (2) Density, weight and hardness. The proportion of wood fibers forming the framework and of other elementary substances contained in wood varies in different parts of the tree, as well as different kinds of trees and also according to age, soil, locality, etc.. No two trees are alike in wood structure. Some woods are more porous than others. For these reasons and many others the wood takes the treatment unequally when exposed to the same retort condition, even if it was possible to bring the wood to a uniform degree of seasoning. No two species of wood have the same anatomical structure. Each one differs from the other in proportion of woody fiber, size, character and arrangement of the wood vessels and wood cells. Some woods take the treatment easier than others. Red oak, for example, takes creosote clear through the heart, while beech under same conditions is very refractory. No doubt this is principally due to the difference in the wood structure of the species. Some engineers have advocated the grouping of various woods according to their degree of absorption, again some have advocated the grouping according to their specific gravity; others would group them according to the density or weight per cubic foot of dry wood, while some say that they should be segregated according to their degree of hardness. To separate woods into so many groups involves a great deal of labor and expense and it is doubtful if the results obtained would justify it. Some experiments have been made to determine the percentage of absorption of various kinds of woods. From the experiments made by Mr. F. J. Angier, for the Chicago, Burlington & Quincy Railroad at Galesburg, Ills., during 1908 and 1909, the woods were divided into three groups, as follows:

Class A. Absorbing less than 22 per cent in volume.
Class B. Absorbing between 23 and 30 per cent.
Class C. Absorbing more than 30 per cent.

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Upwards of 20,000 ties were carefully weighed before and after treatment and a special effort made to find out just what each kind of wood would absorb under normal conditions.

The following table shows a summary of these tests made covering a period of nearly two years. The classes were arranged so that nearly an equal number of woods would fall in each class, there being seven different species of woods in Class A, six in Class B, eight in Class C.

CLASS A.

Kind of Wood.	No. Ties Used in the Tests.	Absorption in Volume %.	Number Months Seasoned in Yard.
Oak, Red	3,112	20.9	6 to 15
Oak, Pin	671	19.5	10
Oak, White	731	14.2	7
Hickory	414	18.8	2 to 8
Beech	2,481	21.8	15
Hemlock	1,364	20.7	8 to 15
Tamarack	2,329	17.1	6 to 8

CLASS B.

Sweet Gum	928	23.0	5 to 9
Chestnut	345	22.6	12
Hard Maple	691	28.3	15
Ash	318	23.0	2 to 6
Sycamore	364	26.6	7
Poplar	1,348	26.8	7 to 9

CLASS C.

Short Leaf Pine	2,192	36.9	5 to 9
Soft Maple	599	33.1	6
Tupelo Gum	790	30.7	8
White Elm	872	36.6	7 to 15
Red Elm	626	34.9	6 to 9
Cypress, White	662	35.4	7 to 8
Red Birch	775	33.0	6 to 9

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The Chicago, Burlington & Quincy Railroad has also made known the results of other experiments, also made by Mr. F. J. Angier, to determine the absorption of the various species of woods treated together under like condition, using the Card Process and an experimental retort. Three or four ties of each kind were treated. All the ties used in this treatment were seasoned at least eight months and carefully selected, so as to be as free as possible from knots and other defects. No steaming or initial vacuum. In each case the solution, consisting of 23 per cent creosote by volume and water containing 5 per cent of zinc-chloride, was introduced at a temperature of 180° F. and a pressure of 150 pounds was maintained for three hours. This was followed by a one-hour vacuum. The results are given in the following table:

Species.	No. Ties Treated.	Wt. per Cu. Ft. Before Treatment.	Gain in Wt. Per Cent.	Absorption per Tie		Net Gain After Vacuum, Per Cent.
				Zn. Chl. Lbs.	Creo. Lbs.	
Cypress	4	27.3	98.01	4.09	16.96	80.0
Cottonwood	4	23.2	88.31	2.11	12.59	68.4
Willow	4	28.6	82.03	2.42	14.43	58.0
Birch	4	38.2	67.93	2.75	16.45	53.0
White Elm	4	34.4	60.50	2.11	12.59	48.5
Poplar	4	27.0	58.74	1.71	10.24	45.2
Soft Maple	4	32.5	50.58	1.69	10.12	44.0
Hemlock	4	31.6	49.46	1.78	10.64	37.6
Short Leaf	4	32.3	44.22	1.47	8.80	27.3
Hard Maple	4	42.0	40.72	1.75	10.46	33.5
Red Gum	3	33.0	36.99	1.45	8.67	29.0
Beech	4	46.0	36.57	1.70	10.18	27.5
Red Oak	3	44.0	35.87	2.12	12.65	32.0
Ash	3	42.3	34.47	1.69	10.12	30.3
Hickory	4	48.4	23.85	1.09	6.55	20.6
Tamarack	4	40.8	20.29	.81	4.83	20.3
White Oak	4	47.0	7.97	.39	2.30	5.98

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Mr. Samuel S. Rowe, who was an authority on wood preservation, furnished the American Railway Engineering and Maintenance of Way Association with his opinion regarding the grouping of timbers. He said:

"The writer herewith submits a statement with relation to proper classification of our American Woods with reference to treating.

Name.	Location.	Wt. Cu. Ft.	Abs. Wt. per cent	A	B	C
Ash (White)	Mich.	37.8	.265		x	
Beech	Ind.	38.7	.214		x	
Cedar (White)	Mont.	20.8	.265		x	
Cherry (Wild)	Ill.	45.4	.170	x		
Cottonwood	Mont.	24.6	.383		x	
Cypress	Tex.	37.2	.246		x	
Elm (Red)	Ill.	33.1	.215		x	
Elm (Rock)	Mich.	46.9	.216		x	
Fir (Douglass)	Mont.	31.7	.212		x	
Fir (Balsam)	N. Mex.	25.4	.227		x	
Gum	Tex.	32.8	.254		x	
Hackberry	Ill.	40.8	.290		x	
Hemlock	Mich.	25.6	.323		x	
Hickory (s. b.)	Mich.	46.8	.200	x or	x	
Linden	Ill.	27.3	.526			x
Maple (Sugar)	Mich.	46.4	.266		x	
Oak (White)	Mo.	46.0	.249		x	
Oak (Black)	Ind.	41.4	.157	x		
Oak (Red)	Ind.	43.5	.169	x		
Oak (Water)	Ind.	46.9	.132	x		
Pine (Lglf.)	Tex.	34.7	.241		x	
Pine (Sht. Leaf)	Tex.	35.2	.249		x	
Pine (So. Yel.)	Tex.	38.2	.231		x	
Pine (Mtn.)	N. Mex.	28.8	.225		x	
Pine (Mtn.)	Colo.	21.2	.299		x	
Pine (Blk. Hills)	S. D.	29.3	.216		x	
Pine (Mich. Wh.)	Mich.	28.2	.494			x
Pine (Pinion)	Colo.	24.8	.324		x	
Pine (Bull)	Mont.	26.5	.220		x	
Pine (Norway)	Mich.	25.6	.238		x	
Pine (Nor. Wh.)		24.3	.278		x	
Pine (White)	N. Mex.	25.3	.225		x	
Pine (White)	Colo.	23.4	.281		x	
Pine (Diseased)	Wyo.	27.8	.402		x	
Pine (Mex., 8 var.)		32.1	.318		x	
Spruce	N. Mex.	31.3	.274		x	
Spruce (Wh.)	Colo.	24.9	.268		x	
Spruce (Wh.)	Mont.	20.8	.250		x	
Spruce (Red)	Colo.	28.7	.261		x	
Spruce (Red)	N. Mex.	33.2	.164	x		
Sycamore	Ill.	41.0	.366		x	
Tamarack	Mont.	32.9	.228		x	

Class A—20 per cent or less.
Class B—20 per cent to 40 per cent.
Class C—Over 40 per cent.

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"The writer has relied upon a long series of tests as to the natural absorptive powers of each kind to take up water when immersed in a normal degree of dryness, believing it would aid in judging of the nature of the timber in practical treating.

"In practice it is found that woods will absorb in the course of the ordinary methods of impregnation under pressure of 100 pounds, while in the solution, about as much as is taken up by immersion in 28 to 30 days, and on this basis the following table is construed:

"Class A: Those that absorb less than 20 per cent in volume.
"Class B: Those absorbing from 20 to 40 per cent; and,
"Class C: Those absorbing over 40 per cent.

"This gives more than 75 per cent in one class (B), making the exceptions hardly worth considering, **and it hardly seems worth while to attempt classification.**"

From the three experiments given above it is apparent that there is a good deal of variation in the percentage of absorption among the different kinds of woods and even among the same species.

In the first set of experiments made by Mr. Angier, given above, he found red oak absorbed in volume 20.9 per cent, while in the second experiment he found that it absorbed 32 per cent; and the beech in the first experiment absorbed 21.8 per cent, while in the second experiment 27.5 per cent. In Mr. Rowe's classification he gives the per cent of absorption of red oak as 16.9 per cent and of beech 21.4 per cent.

So much depends upon the character and condition of the wood and the pressure, temperature and character of the preservative, that it is very difficult to determine, with any degree of accuracy, the relative percentage of absorption of the various kinds of woods. It is almost impossible to arrive at the same results when woods are treated under different conditions, so that no rule can be safely established regarding the classifying of timbers.

The New York Central Lines requires the separation of woods, accepted for treatment, into five groups, but the grouping was not determined by actual experiments. One of the contracts with the treating company provides that the various woods be separated into groups as follows:

(1) Beech and sycamore.
(2) Gum and elm.
(3) Red, black and water oak.

Various other woods as experience shows can be grouped together.

In another contract made with the same treating company some years later, it provided that the various woods be separated into the following groups:

(1) Beech.
(2) Hickory and sugar maple.
(3) Red, black and water oak.

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Various other woods as experience demonstrates can be grouped together.

When the writer was General Tie Agent of the New York Central Lines, he undertook to group the timbers in such a manner as to comply with the specifications contained in these contracts, with the results that the various species were grouped as follows:

GROUP No. 1.

Red Oak.
Pin Oak or Swamp Spanish Oak.
Black or Yellow Oak.
Spanish Oak.
Water Oak or Jack Oak.
Scarlet Oak.
Shingle Oak or Scarlet Oak.
Willow Oak.
Honey Locust or Honey Shucks.

GROUP No. 2.

Beech.
Sweet Birch or Black Birch.

GROUP No. 3.

Sugar Maple or Rock Maple.
White Ash.
Butternut or Swamp Hickory.
Shellbark Hickory.
Mockernut Hickory.
Pignut Hickory.
Hackberry, Sugarberry or Nettle Tree.

GROUP No. 4.

Silver Maple, Soft Maple or White Maple.
Red Maple, Swamp Maple or Soft Maple.
Sycamore.
Red Birch or River Birch.
White Elm, American Elm or Water Elm.
Cork Elm, Rock Elm or Hickory Elm.
Tupelo, Pepperidge, Sour Gum or Black Gum.

GROUP No. 5.

Red Gum, Sweet Gum or Liquidambar.

After three years' trial in separating the different species of woods, the writer comes to the same conclusion as Mr. Samuel S. Rowe, that it is hardly worth while to attempt a classification. It involves con-

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siderable labor and expense to separate the ties into groups and perhaps just as good results would be obtained, under present method of treatment, if the woods were not separated at all.

The percentage of absorption of the various kinds of woods is only one of the many factors that enter into the problem, and no undue consideration should be given to it. Due consideration should be given to all factors and it is useless to go into extreme refinements concerning one or two influences and neglect wholly or in part the others, for the deductions will be both incorrect and misleading.

Some engineers think that the groups should be governed by the "specific gravity" of the wood, or "density," or "weight" per cubic foot of dry wood. This rule would apply in general, but there are many exceptions. There are some woods that are light, yet difficult to treat, while there are some that are heavy and easy to treat. Again some engineers would classify or group the timbers, according to their degree of "hardness." Hardness in wood is rather an indefinite term, because the hardness manifests itself differently when such different kinds of instruments are applied to the wood, as the ax, knife, plane, saw, nail, etc., some of which would work parallel to the fibers and others at right angle to them. However, it has been found that it is not always the hardest woods that are most refractory, nor the softest woods always the easiest to treat. As a general rule, perhaps, it is so, but there are several exceptions. For example, red oak is considered a comparatively hard wood, yet it is easy to treat, whereas red gum is a much softer wood, yet more refractory.

In view of the foregoing it is evident that no satisfactory grouping can be made of the various kinds of woods, either according to their absorptive powers or penetrability, or weight per cubic foot, or density and resistance to penetration, or hardness, and in the opinion of the writer it is futile to attempt it.

(3) PER CENT OF HEART WOOD AND SAP WOOD.

The percentage of heart wood and sap wood in timber is another important factor in the problem of grouping timbers for treatment. No two pieces of timber can be found with exactly the same percentage of heart wood and sap wood. The proportion of the heart wood and sap wood in a finished product, depends upon the size of the tree, the part of the tree from which it was obtained and upon the size and shape of the manufactured product. The sap wood is considerably more porous than the heart wood in all kinds of woods, therefore the former takes the treatment much easier than the latter. The depth of the preservative absorbed depends upon the resistance of the wood to injection, consequently it requires less time and less pressure to treat the sap wood than it does the heart wood. In treating woods with varying percentages of heart wood and sap wood in the same cylinder, the sap wood naturally

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absorbs more oil than the heart wood, and if only a limited amount of oil is injected in the material, it is probable that the heart wood might not receive any treatment, or at any rate, only partially, as the limited amount of oil would all be absorbed by the sap wood. However, if the material is treated to a refusal the heart wood would absorb all that is possible to inject into it, after the sap wood has imbibed all that it can contain.

It has been suggested by some engineers that the ties and timbers be grouped as follows:

Heart, less than 20 per cent.
Intermediate, more than 20 per cent and less than 50 per cent.
Sap, more than 50 per cent.

It must be apparent to anyone that is acquainted with the conditions at treating plants that it is impractical to group ties or timbers in such a manner. The material is usually loaded on tram buggies, by day laborers, who possess very little scientific knowledge of this character and who cannot be expected to examine every piece of timber as they load it on the trams to determine the percentage of heart wood and sap wood, so as to know to which of the three classes it belongs.

We have considered the three main factors that enter into the problem of grouping, but there are several others that might be mentioned, such as size and shape of ties and timbers, whether sawed or hewed, method or process of treatment, etc., but we will not attempt to discuss them in this paper.

In conclusion, it might seem at first that a suitable grouping could be predicated upon the moisture content or degree of seasoning, or upon the known structural characteristic of the various species, or upon the relative percentage of heart wood and sap wood, but it must be apparent from the foregoing that it sounds well in theory, but cannot be worked out in practice. The opinions regarding the proper grouping of ties for treatment are so contradictory and reliable data are so meager and there are so many factors that enter into the problem, it is deemed inadvisable, in the opinion of the writer, to attempt it. **Some method or process can perhaps be devised whereby it would be unnecessary to separate the ties or timbers into so many groups for treatment.** It is easy enough to discuss the probable behavior of certain species from a purely theoretical point of view, taking into consideration the physiological structure of the different timbers, their organic cell contents, their percentage of heart wood and sap wood, etc., but experience has shown very emphatically that the controlling factors which influence the absorption of different preservatives by different processes, are so complex that theoretical deductions are erroneous more often than correct.

W. F. GOLTRA.

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GROUPING TIMBERS FOR TREATMENT.

July 16th, 1912.

Editor, Railway and Engineering Review,
Chicago, Ill.

Dear Sir—During the past eight or ten years, or since creosote oil has been used extensively, for treating railroad ties in this country, there has been a prevailing notion that in order to secure the best results from the treatment, it is necessary to separate them into groups or classes before placing them in the retorts, so that each and every tie will absorb an equal quantity of creosote oil, thus obtaining a more uniform penetration and absorption, than would otherwise be had if they were not separated. There are a good many factors entering into the problem and to give due consideration to all of them would require the separation of ties into a large number of groups. This necessarily involves considerable labor and expense, and unless a greater uniformity of treatment is obtained by such separation, there would be no justification for separating them into groups for treatment. The writer read a paper on this subject at the meeting of the American Wood Preservers' Association held in January, 1911. In the paper he stated that it involved considerable labor and expense to separate ties into groups, and from his personal observations, as good results would be obtained if the woods were not separated at all. Furthermore that some method or process could no doubt be devised whereby it would be unnecessary to separate them into so many groups for treatment. There was very little discussion of this paper and few of the members present agreed with the above proposition. It being generally understood that the grouping of ties with respect to species, proportion of heartwood and sapwood, degree of seasoning, etc., is essential to secure uniform absorption. A few moments after the conclusion of the reading of the paper, and before there was any general discussion, a member offered the following resolutions for the consideration of the Association:

Resolved, That in the opinion of this Association the treatment in the same cylinder charge of ties having great dissimilarity of permeability is not expected to give the best results until the treatment is carried to total refusal; and

Resolved, That in the opinion of this Association the time of treatment required to obtain total refusal varies in different species and with different seasoning so much as to make for serious delay in the case of ties which have first reached totality waiting in the cylinder for more refractory to obtain it; and

Resolved, That in the opinion of this Association the sorting of timbers before treatment is progress in the right direction.

The resolutions were adopted without discussion and almost unanimously; it being a general accepted fact by those versed in timber treating that ties should be grouped for treatment. Referring to the writer's paper, President Buehler, remarked, "That statement, gentlemen, undermines what has up to date been practically an axiom of

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Fig. 1

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wood preservation, and we ought to have it thoroughly discussed. It is important that we hear from the practical men who have had charge of timber preserving plants for a number of years. It brings out an entirely new thought. We have always advocated the necessity of separating timbers into groups. Now, we hear an advocate of non-separation which is entirely in opposition to anything we have ever thought of along this line. Our whole development has been towards the separation of timbers into groups.''

My statement was made after careful study and painstaking observations and with a full realization of what it means to assail a notion that is firmly entrenched in the minds of many people. However, it matters not how many people disagree with me on this proposition, it shall not deter me from expressing my honest opinion on the subject and submit some facts to support my assertion.

In order to prove my assertion that it is unnecessary to separate ties into groups for treatment, we offer the record of two experiments, made on a large scale, in actual practice. One of these experiments was made at the treating plant of the American Cresoting Company at Shirley, Ind., in December, 1909. This plant treats ties for the C. C. C. & St. L. Ry. Co. and allied lines. The experiment was made in the regular course of business, by weighing a large number of ties before and after treatment to ascertain the quantity of oil left in each tie. Also to note the range or variation in the absorption of ties of the same species and also that of various species mixed together in the retorts. The results are shown on the accompanying drawing, Fig. 1, which we think will be a revelation to many people. The wide range in weights of ties themselves before treatment, as well as the quantity of oil absorbed, is surprising.

In this experiment, 1,020 ties were weighed before and after treatment. The ties were grouped into three classes, according to species, as follows:

Class 1.—Red oak, black oak, pin oak and water oak.

Class 2.—Beech, exclusively.

Class 3.—Maple, hickory, hackberry, sycamore, birch, black gum, elm and yellow pine.

The ties were taken from piles and loaded on tram cars by the treating company, in the usual manner, and the truck loads were then placed near the weighing scales. The weighers affixed a metal tag numbered consecutively to identify the ties, recorded their weights before treatment, and then placed them on other trucks. When the entire truckload consisting of about 50 ties had been weighed it was run into the cylinder with fourteen other trucks, making up a full charge. After withdrawing the charge from the cylinder the truck load of ties was re-weighed and the amount of oil absorbed by each tie thus ascertained. Twenty truck loads were weighed in this manner. A summary of the results of each charge is as follows:

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Exp. No.	Class.	No. Ties.	Weight Lbs.	Range Lbs.	Average Weight.	Charge No.	Temp. in Retort Fhr.	Pressure.		Vacuum.		Total Absorp. Lbs.	Range Lbs.	Average Absorp. per Tie.
								Lbs.	Time Mins.	Ins.	Time Mins.			
1	1	56	7780	111 to 179	139	3572	170	175	135	24	60	803	6 to 25	14.35
2	1	56	6677	93 159	119	3582	175	175	30	23	60	1169	8 39	20.82
3	2	56	7168	104 157	128	3564	170	140	45	24	60	1301	10 43	23.23
4	2	54	8138	108 192	151	3573	170	175	90	22	60	1333	4 50	24.68
5	2	49	7855	126 192	160	3578	170	175	60	25	45	1015	4 34	20.75
6	2	55	8276	99 184	150	3579	170	175	60	23	45	1204	10 39	21.89
7	2	48	7814	135 189	163	3588	170	175	30	22	45	1056	8 35	22.00
8	3	52	5874	82 152	113	3565	175	175	60	21	45	1486	12 53	28.57
9	3	35	4145	91 207	118	3569	170	155	30	23	60	658	3 33	18.75
10	3	43	6040	85 168	141	3570	170	150	45	24	45	1083	11 43	25.18
11	3	51	5757	76 160	113	3574	170	155	30	24	60	1011	7 30	19.83
12	3	52	6113	84 161	118	3575	170	150	45	22	45	1239	10 45	23.82
13	3	58	5631	63 129	97	3576	170	130	30	24	60	1280	9 48	22.07
14	3	50	6234	87 162	125	3577	170	160	30	23	60	928	6 36	18.56
15	3	54	5601	70 144	104	3581	170	165	30	23	60	1229	10 51	22.75
16	3	44	6001	113 200	136	3584	170	150	45	22	45	932	13 34	21.18
17	3	52	6156	86 164	118	3580	170	135	30	25	60	1079	2 39	20.56
18	3	55	5557	77 139	101	3585	170	160	30	24	60	1042	8 32	18.90
19	3	46	6626	97 184	144	3587	175	170	30	24	60	989	3 30	21.50
20	3	54	6168	86 149	114	3591	170	170	30	25	60	1287	8 60	23.83
		1020	129,611		127							22,124		21.70

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The contract between the treating company and the railroad company requires that 2½ gallons, equivalent to 21¾ pounds, of creosote oil be left in each tie. It will be observed that the average absorption of the above ties is very close indeed, namely 21.70 pounds. The total absorption was 22,124 pounds. But, it should be observed that the variation of absorption ranged from two pounds to sixty pounds per tie, 548 ties or only 54 per cent. of the total number absorbed 17 to 26 pounds of oil and 472 ties or 46 per cent. absorbed more or less than these quantities. (Creosote oil weighs 8.7 pounds per gallon and if a variation in the amount left in each tie does not exceed one-half gallon more or less, the weight of oil would range from 17 to 26 pounds inclusive.) In a general way the depth of penetration was in proportion to the quantity of oil absorbed; those ties absorbing from six to ten pounds had a penetration of about one-quarter of an inch, whereas those which absorbed fifty to sixty pounds were probably thoroughly saturated. The average penetration was about three-quarters of an inch, which was determined by boring a large percentage of the ties. In this experiment there was seventeen truck loads of 6″ x 8″ x 8′ and three truck loads of 7″ x 8″ x 8½′ ties. No distinction was made by the treating company in treating these two sizes—both are treated with an average of 2½ gallons of oil per tie. Again another fact should be observed, and that is the great variation of the weights of the ties themselves before treatment. One tie weighed as little as 63 pounds, while another weighed as much as 207 pounds; the average of all was 127 pounds.

Let us analyze some of the above charges. Experiment No. 1, charge 3572, consisted of 56 6″ x 8″ x 8′ red oak ties, weighing from 111 to 179 pounds, or an average of 139 pounds. Fourteen of these ties, weighing an average of 141 pounds, absorbed an average of 7½ pounds of oil. At the same time fourteen ties having an average weight of 140 pounds absorbed an average of 21 pounds of oil, and the whole truck load in the charge absorbed 14.35 pounds per tie. The duration of the pressure was 2¼ hours. Why should there be such a variation in the absorption? The ties are of the same species of wood; approximately of the same size; come out of the same pile of ties in the yard, where they underwent air seasoning. The treating operation is the same, because they are in the same truck load in the cylinder. It is strange, yet nevertheless an undisputable fact. We attribute the difference of the variation in the absorption principally to the following causes: (1) Variable texture of the wood, (2) proportion of heartwood and sap wood, (3) the drying of the saps in the cells, clogging and gumming the pores, thus resisting the entrance of the fluid, and (4) different degree of seasoning. Some ties may have seasoned faster than others on account of their position in the piles. There are probably many other reasons that may be advanced, but these will, at least partially, explain the causes for the wide variation in the absorption.

Experiment No. 2, charge 3582, consisted of 56 6″ x 8″ x 8′ red oak ties, ranging in weight from 93 pounds to 159 pounds, or an average

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of 119 pounds. Duration of pressure 30 minutes. Fourteen ties weighing an average of 122 pounds absorbed an average of 14 pounds of oil, while fourteen ties having an average weight of 113 pounds absorbed an average of 29 pounds of oil. The whole truck load in this charge absorbed an average of 20.82 pounds per tie. It would appear that the former was not as well seasoned as the latter, consequently weighed more and absorbed less oil. But a closer analysis of the weights do not fully bear out this fact, as one tie weighing 91 pounds absorbed 14 pounds of oil, while another tie—the very next to it—weighing 96 pounds absorbed 30 pounds of oil. Both ties were from the same pile, approximately the same size, manufactured in the same manner, and were seasoned in the yard the same length of time. How are we to account for such a wide variation? Again in this same truck load one tie weighing 105 pounds absorbed 8 pounds of oil, while another weighing 102 pounds absorbed 38 pounds. This may be due to a different proportion of heartwood and sapwood in each stick. It is manifest that the amount of oil that will be absorbed by ties cannot be predicated upon their degree of seasoning or proportion of heart wood or sapwood, therefore it is impracticable, if not impossible, to separate them into groups that will effect greater uniformity of absorption.

Experiments 3, 4, 5, 6 and 7, charges 3564, 3673, 3578, 3579 and 3588, consisted of beech exclusively. The weights of the ties in these several charges ranged from 99 pounds to 192 pounds and absorbed from four to fifty pounds of oil per tie. The duration of pressure was from thirty minutes to one and one-half hours. The wide variation in the absorption, notwithstanding all of the ties were manufactured from the single species of beech, is surprising and it must be apparent to anyone that the separation of timbers into groups according to species does not achieve the object sought, namely, a uniform absorption of the antiseptic. The variation is just about the same as in other species and therefore it is useless to segregate ties into different species, as the variation in the absorption would not in any way be lessened. The species or character of the timber is only one of the many factors which influence the amount of absorption and no undue consideration should be given to it.

The foregoing remarks regarding oak and beech ties also apply to experiments Nos. 8 to 20 inclusive, consisting of maple, hickory, hackberry, sycamore, birch, black gum, elm and yellow pine. All of these species were mixed and treated in the same cylinder. The variation in weights of ties, as well as in the quantity of oil absorbed, is surprising and no sorting of any kind would make the treatment more uniform. It is impracticable, if not impossible, to sort or group ties in any manner whatever, that will produce uniform absorption and penetration. There will be a wide variation of the amount of liquid absorbed by different ties no matter how they are grouped, or by what process they are treated. The grouping of ties for treatment sounds well in theory, but does not work out in practice.

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No attempt should be made to group ties according to species, proportion of heartwood and sapwood, degree of seasoning, etc., as it is useless and does not accomplish the object sought, but instead would suggest that they should be first thoroughly seasoned, either in open air or artifically, and then run into the impregnating retort without any sorting and treated to **total refusal.**

Woods have great dissimilarity of permeability and therefore best results will not be obtained until the treatment is carried to total refusal. If ties are treated in this manner it will obviate the necessity of separating them into groups. We know very well that some woods are more refractory than others and must remain longer under pressure, but it is not practical to separate them on account of that feature alone. As above demonstrated there are many other factors which affect the duration of pressure and amount of absorption, some invisible, some counteracting others, and perhaps some yet unknown. It will be observed from the above experiments that there is a wide variation in the duration of the pressure applied on a single species. For example, red oak ties in charge 3572 were under pressure 2¼ hours, while same species in charge 3582 was under pressure only 30 minutes, yet the former absorbed an average of only 14.35 pounds, while the latter absorbed 20.32 pounds per tie.

What does this "serious delay" mentioned in the above resolutions amount to? Let us see. Upon examination of the weekly reports of the treatment of 109 charges, numbered 3485 to 3593 inclusive, treated at Shirley, Ind., between November 15th and December 18th, 1909, we note the duration of pressure as follows:

Class.	Number of charge.	Duration of pressure, minutes.	Range, minutes.	Average duration of pressure, minutes.
1	41	5375	30 to 240	130
2	23	1530	30 135	66
3	45	1965	15 120	44
	109	8870		81

From the above table it will be observed that the maximum duration of pressure was four hours, which was applied on oak ties, while the minimum duration of pressure was fifteeen minutes, applied on mixed woods. Some ties absorbed the oil so quickly that they had taken up the limited amount of 2½ gallons specified in contract, before the pressure could be fairly applied. Some of the ties absorbed considerable oil, while others imbibed very little.

We claim that if ties are thoroughly seasoned, particularly by artificial method, which is speedier and more efficient than natural air seasoning, they may be run into the impregnating retorts without separation into groups and can be treated to refusal in an average time

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of ninety minutes, whether they are treated with creosote oil, zinc chloride, or asphalt crude oil.

It is a serious mistake to treat ties only partially. Contracts which specify only a certain amount of oil per tie are faulty. Thorough and complete impregnation is of the first consideration and the treatment should be carried to total refusal regardless of whether creosote oil or zinc chloride or any other preservative is employed. To treat ties to refusal with creosote oil exclusively would no doubt be rather expensive and extravagant in this country. In Europe, the treatment is generally carried to refusal, even where creosote oil is employed exclusively, but it should be borne in mind that creosote oil costs only about one-half of what it does in this country. Zinc chloride alone or in combination with creosote oil can be used advantageously and ties can be treated to refusal at a moderate cost. All railroads in this country, who have in the past, or are now using zinc chloride, or combination of zinc chloride and creosote, treat their ties to total refusal. The strongest advocates of separating timbers into groups for treatment are those who seek to promote their patented creosoting processes for treatment of ties on the railroads of this country.

A second experiment was made at the plant of the Federal Creosoting Company at Toledo, Ohio, in September, 1911. Only one species and one size of timber was experimented upon. Nine hundred and seventy 6″ x 8″ x 8′ red oak ties were weighed before and after treatment and the results are shown on the chart accompanying. The range in weights of the ties and in absorption of oil per tie is practically the same as the Shirley experiment. The weights of ties range from 81 pounds to 205 pounds; the average weight was 135 pounds, or 8 pounds more than the average weight at Shirley. The difference is perhaps mainly due to two causes. First, the Shirley ties were perhaps drier than the Toledo ties, having been in the yard for a longer period, and second, the former consisted of mixed woods, some of which dry quicker and weigh less than red oak, whereas the latter consisted exclusively of red oak. It is generally known that it requires more time to season the oaks than beech and other kinds of woods. In France it is the rule to allow oak to season two years and beech six months before treating. In this country very little attention has been paid to length of time that each species of wood should be seasoned, consequently the ties are in various degrees of dryness when placed in the retorts for treatment.

The total absorption of oil in the Toledo experiment was 18,994 or an average of 19.58 pounds. It will be observed that this amount is less than the amount called for in the contract between the railroad and the treating company, but it is only fair to state that it is probable that the other ties, in the same charge, absorbed enough more than 21¾ pounds to make up the average specified in the contract. Of the 970 ties treated, 467 ties or 48 per cent of the total number absorbed 17 to 26 pounds of oil and 503 or 52 per cent absorbed more or less than these quantities.

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The absorption or amount of oil left in the ties ranged from two pounds to 61 pounds and the penetration was about the same as in the Shirley experiment.

These experiments should be conclusive evidence that no uniformity of absorption can be obtained by grouping the woods according to species, nor can the variation be diminished by grouping the ties according to proportion of heart wood and sap wood, degree of seasoning or any other factors which influence the amount of absorption. It is impossible to predicate, with any degree of accuracy, the quantity of oil or antiseptic that any particular tie will absorb and the only way to treat ties thoroughly and have the assurance that they are treated properly is to inject the fluid into them to total refusal, after they have been thoroughly and properly seasoned.

In February, 1904, the C. C. C. & St. L. Ry. Co., made a contract with the Columbia Creosoting Company, who have since been succeeded by the American Creosoting Company, for which the specifications regarding grouping of woods, reads as follows:

Section 11. The various timber shall be sorted for shipping, so that ties of the same density, as nearly as possible, may be treated together and the following schedule shall be followed.

Beech and sycamore to be stacked together.
Gum and elm to be stacked together.
Red, black and water oak to be stacked together.

The various other woods as experiments show can be worked together. The foregoing schedule to be observed in the shipment of ties to the plant for treating.

In November, 1905, a supplemental contract was made by the C. C. C. & St. L. Ry. with the Columbia Creosoting Company, and the specifications regarding the amount of absorption of oil, read as follows:

Section 3. That the said first party (Col. Creo. Co.) shall hereafter, at the request of the said second party (C. C. C. & St. L. Ry.) treat cross ties to conform to the above specifications as to width and thickness, but as long as eight and one-half (8½) feet without any additional charges for such additional length, and that in so treating said ties eight and one-half (8½) feet in length it will inject at least four gallons of creosote oil provided for by said agreement per tie, and that of said four gallons of creosote oil per tie so much shall be withdrawn by vacuum as to leave an average of not less than two and one-half (2½) gallons of oil in each and every tie.

Four agreements were executed in March, 1907, between the Rock Island-Frisco Lines and the American Creosoting Company, for treating plants at Kansas City, Mo., Springfield, Mo., Hugo, Okla., and Marion, Ills., the specifications regarding the separation of ties into groups and absorption of oil per tie, reads as follows:

Article 9, Section 5. It is understood by the parties hereto that the best results from treatment cannot be secured unless ties of the same character are treated separately from those of a different character, and unless ties of substantially the same degree of seasoning are treated together. The Railroad Company, therefore, agrees, as nearly as may be practicable, to deliver at said plants all ties in the order of their cutting, and in stacking, and loading ties into cars for shipment to separate the

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different wood from which such ties are cut in accordance with the following schedule, viz:

Beech, separate.
Hickory and sugar maple, together.
Sycamore and elm, together.
Red, black and water oak, together.

Article 6, Section 1, reads as follows:

(a) All ties shall be treated by what is known as the Lowry Creosoting process, which is now used by the Columbia Creosoting Company at Shirley, Ind. An average of not less than two and one-half (2½) gallons of creosote oil shall be left in each tie when the treatment of the same is completed, with variation of not more than one-half (½) gallon in ninety-five (95%) per cent of the ties treated, unless the Railroad Company shall otherwise direct.

The word "average," as last above used is understood to refer to individual ties and not to ties taken up as a whole or in lots, and due regard shall be had to the physical properties and conditions of woods, at the time of treatment.

In May, 1909, the L. S. & M. S. Ry. Co. made a contract with the Federal Creosoting Company, for treating ties for various New York Central Lines and the specifications regarding the grouping of woods and absorption of oil, reads as follows:

Section 5. It is understood by the parties hereto that the best results from treatment cannot be secured unless ties of the same character are treated separately from those of a different character, and unless ties of substantially the same degree of seasoning are treated together. The Railroad Company, therefore, agrees, as nearly as may be practicable, to deliver at said plant all ties in the order of their cutting and in stacking and loading ties into cars for shipment to separate the different woods from which such ties are cut out in accordance with the following schedule, viz:

Beech, separate.
Hickory and sugar, together.
Sycamore and elm, together.
Red, black and water oak, together.

and other timbers as experience demonstrates can be best treated.

(These specifications are practically the same as in the Rock Island-Frisco Lines contracts and evidently copied from them.)

Article 6, Section 1. (a) All ties shall be treated by what is known as the Lowry Creosoting process, which is now used by the Columbia Creosoting Company, at Shirley, Ind. An amount of not less than two and one-half (2½) gallons of creosote oil shall be left in each tie when the treatment of the same is completed, unless the railroad company shall otherwise, in writing, direct.

(In these specifications the variation of absorption is not limited as it is in the Rock Island-Frisco contract.)

The futility of these provisions in contracts between railroad and treating companies is obvious. The specifications are not fulfilled and a very large proportion of the ties receive only a superficial treatment. It is also apparent that some of the ties absorb an undue proportion of the oil, perhaps due to decay of the ties on the interior.

Many experiments have been made by various treating companies, assisted by men in the Forest Service of the United States, with a view

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of formulating some practical rules for sorting and grouping ties for treatment, but none have as yet succeeded. But there are some people who are unable to see a better way of economizing time and labor and enhancing the quality of treatment, and these continue in the belief that "sorting of timbers before treatment is progress in the right direction."

In conclusion we give the following summary and recommendations:

1. It is useless and impracticable to group ties for treatment according to species, proportion of heart wood and sap wood, degree of seasoning, etc.

2. Ties should be thoroughly seasoned (preferably by artificial method) and treated to total refusal.

3. Zinc chloride alone or in combination with creosote oil is more economical than creosote alone in treating railroad ties to refusal.

W. F. GOLTRA.

(EDITORIAL RAILWAY AND ENGINEERNIG REVIEW, AUGUST 10, 1912.)

THE GROUPING AND KILN DRYING OF TIES FOR TREATMENT.

About a year ago attention was called through these columns to some inferior work that was being done in the treatment of hardwood ties with creosote. The observations on which the comment at that time was based covered work quite widely prevailing among the railroads. The extreme variability of penetration of the creosote in different ties suggested that in the work of treatment the aim had been to inject only a limited quantity of creosote per cubic unit of timber, and it was proposed that whenever such was the plan followed more attention should be given to the grouping of timbers, with a view to secure more uniform penetration. The idea was that without such grouping the ties easily penetrable would absorb the bulk of the solution and the refractory ones would receive but little of it. Judging from results alone it was suspected that such had been the history of many ties that had been treated and laid in the track; in other words, it seemed reasonable to suspect that the injection of creosote into the ties had been stopped after the timber had received a limited quantity of it and that they had been treated without grouping with regard to penetrability. It was also pointed out that grouping timbers by species or by classification as to hardness might fall short of what was wanted, the idea being that the degree of seasoning, ratio of heart wood and sap wood and physical characteristics of growth were the factors most vitally associated with penetrableness.

During the year that has passed this subject has been threshed over a great deal in this journal and we think that some information of importance has been brought to light. In the first place, no one having to do with the work of creosoting, by any of the processes, patented or otherwise, has admitted the practice of injecting a limited quantity of

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solution. It seems to be generally conceded that nothing short of treatment of the timber to total refusal can be satisfactory. That being the case the question of grouping becomes one of commercial economy and not of efficiency of treatment. The majority of wood preservers approve of grouping timbers before treatment on the claim that, unless the timbers be grouped with some consideration for penetrability, expensive delays in holding all of the timbers in the retorts until the most refractory ones have absorbed the solution to refusal is likely to result. Coming down to the critical point of this matter, however, we find that in most cases the practice is to group timbers only by species, and among hardwoods it is frequently the case that several species are grouped in a class. Only comparatively few wood preservers seem to have paid any attention to grouping timbers according to proportion of heart wood and sap wood or degree of seasoning; and no one, so far as we have been informed, professes to be able to assort timbers of the same species, equally seasoned and having similar proportion of heart wood and sap wood, as to density of ring growth or other physical characteristics affecting the penetrability.

In Mr. Goltra's article on grouping of timbers for treatment, published in our issue of last week, that gentleman presents what seems to be a pretty thorough study of the subject, supporting his claims, which he announced about 18 months previous, to the effect that, "it is useless and impracticable to group ties for treatment according to species, proportion of heart wood and sap wood, degree of seasoning, etc."

The array of argument, founded on the result of practical work, which he brings in support of these conclusions, is indeed very strong. According to his findings the results after grouping ties according to the classifications noted are practically the same as when no grouping is attempted. According to his view, therefore, the only logical solution is to inject the solution to the point of total refusal in all cases and whatever the method grouping may be this takes as much time as though no grouping were attempted.

It must be admitted that assortment of timbers according to the degree of seasoning, as applying to ties of the same species in the same pile, would be a difficult matter, and yet degree of seasoning must be an important factor concerning the matter of penetration of the treating solution. We imagine that still greater difficulty or uncertainty would attach to the question of selecting timbers according to density of growth, or an attempt at classification along the line of physical characteristics of growth, by visual inspection.

Mr. Goltra's conclusion is, therefore, that, in order to obtain approximate equality as to degree of seasoning or a certainty that the ties are seasoned to a desirable extent, they should be seasoned by artificial method. According to his views, the expense of artificial seasoning would be offset by more rapid handling of the ties through the plant, thereby involving less capital tied up in ties piled for seasoning. The artificial seasoning of timber in drying ovens is nothing new; in fact, it is an old method of quickly seasoning timber for various commercial purposes.

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For instance, in the manufacture of vehicles, furniture and in many other woodworking industries, timbers are usually allowed to air season in piles for a year or more, often under cover from the weather, but such seasoning is considered inadequate for working the timber into final shape, and it is thoroughly kiln-dried for adapting it to its purpose. Granting that many of our hardwood timbers are difficult of penetration by chemical solution, does it not seem reasonable that these timbers should be brought to the most susceptible condition for treatment before attempting to apply such treatment? In contrast with the time and care that is given to the seasoning of timber in the manufacturing industries, how unreasonable it is to expect that the air seasoning of ties three to six months, in common practice at our tie preserving plants, could put these timbers in desirable condition for treatment. In European practice ties are generally allowed to season much longer before treatment than is the case in American practice; the usual period of air seasoning there being eight to twelve months or longer.

Neither is the proposition of Mr. Goltra to season timber in the form of ties by artificial method a novel one, for it has been practiced in Europe to considerable extent. On the Eastern Railway of France the kiln drying of ties before creosoting them has been the standard method, the ties being at first piled in the open air, and then held in drying ovens for about three days, at a temperature sometimes ranging as high as 175 deg. F. From the drying ovens the ties are run immediately into the treating cylinders and subjected to vacuum before the injection of creosote. After a long experience with the method of kiln drying timber before treatment it has been found to produce the most effective results.

(PUBLISHED IN RAILWAY AND ENGINEERING REVIEW, AUGUST 17, 1912.)

GROUPING AND KILN DRYING TIES FOR TREATMENT.

Bradford, Pa., August 12, 1912.

Editor, Railway and Engineering Review:

It is cause for no little gratification that the Review should give an increasing amount of space, and especially the aid of its editorial columns, to the problems which confront the timber preserver. In the handling of such problems unusual care must be exercised, in any endeavor to throw light on the subject, that no foreign object intervenes, either to cast a shadow or alter the true color. Furthermore, confusion is heightened whenever an attempt is made to talk about more than one thing at a time, however much one thing may depend on the other.

As the writer of the "resolutions" quoted by Mr. Goltra (see his paper in Railway and Engineering Review of August 3rd, on "Grouping" and your editorial in the issue of August 10th) I derive an exceptional interest in the discussion. At the outset he does not appear to have printed anything which was in principle unknown to the men who voted

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for the "resolutions." His tabulation is on the "Lowry Process" which is expected to "withdraw the surplus creosote" and one might assume from it that more was withdrawn from some ties than from others, but no deduction could be made from it either that the ties were, or were not, properly treated, or that they would exhibit a greater or less individual deviation from the average absorption if they had been treated to "refusal" which obviously in many cases they were not.

The fact is that any given "breed" of tie performs sufficiently true to type. Without indulging in anything fanciful it can be assumed that one "breed" will have the allotted portion by the time the pressure of preservative in the retort has reached 50 lbs.; another waits for 125 lbs.; another waits for 200 lbs.; while another will require 200 lbs. for two hours. Still another holds out for four hours, and another for a dozen hours, size and seasoning being identical in all cases. The time taken to reach "totality" shows corresponding figures. Can it be denied that, without sorting, the soft woods would rob the more refractory, or that if treatment were carried to totality a scattering supply of refractory sticks would use up an unconscionable time?

In a country where bull pine and red fir ties arrive in the same cars, and, believe me, there is such a country—"totality," with zinc chloride was reached in 3½ hours with the pine and twice that in the fir. With 20% of fir in the supply, the question of the advisability of sorting was solved by mathematics; although today the location of soft woods in other places than curved track might force sorting without consideration of treatment at all.

I read with surprise your editorial conclusion that "it seems to be quite generally conceded that nothing short of treatment of the timbers to total refusal can be satisfactory." The subject is infrequently discussed and the ground is occupied by certain "standard engineering specifications" regarding "the amount of preservative necessary for various purposes" which amount does not, in the case of creosote, savor of totality.

Is it not true that in the case of track ties, the railroads have steered a middle course? We hear, in the case of creosote, of "the amount necessary to balance mechanical life" and we put in half what is used in the Old World. Many roads use more or less zinc chloride, not, I judge, because they think that they are going to "beat the time" of creosote, but because they believed it a better business proposition. Probably even with them the treatment of thoroughly seasoned ties "to refusal" doesn't happen every day.

Ties should be seasoned, which costs money, and doubtless for that reason Mr. Goltra is advocating a plan for the purpose. "Seventy-two hours for kiln drying" is of course due to the thickness of the sticks and would be longer, to prevent cracking, if the timber had not already been "seasoned for many months." Considering the well known shrinkage difference of different species, and sizes also, I should be greatly surprised if diligent sorting should not be a necessary preliminary to proper scientific efficient kiln drying. Steaming costs money, kiln drying

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costs more money, and an extra handling of the ties more yet. The first is used in this country largely, with a water solution of zinc chloride, to get the preservative to remain in the tie, a thermodynamic function. Kiln drying in Europe, using eight gallons of creosote, has similar functions, with the reverse attribute.

It should be pointed out that eight gallons of creosote go with an expense for track fastenings, ballast, and alignment, which American roads are not ready to incur; and no other process has been shown to do the work of eight gallons of creosote.

It is necessary to crawl before one can walk. Put conveying machinery into a treating plant and sorting and storing will be easy.

D. BURKHALTER.

(EDITORIAL RAILWAY AND ENGINEERING REVIEW, AUGUST 17, 1912.)

CONCERNING TIE TREATMENT.

Elsewhere in this issue a correspondent comments upon articles published in the Railway and Engineering Review, last week and the week previous, concerning the grouping and kiln drying of ties for treatment. He expresses surprise at this remark quoted from our editorial of August 10th: "It seems to be quite generally conceded that nothing short of the treatment of the timbers to total refusal can be satisfactory."

This statement of ours had reference to various discussions of the subject of creosoting which had been published in the Railway and Engineering Review during the past year. In many instances these discussions were by persons concerned with, or by persons who sought to defend the use of those partial or modified creosoting processes whereby a portion of the creosote is supposed to be withdrawn after injection. Some of these who had discussed this phase of the question had argued that unless such processes were first worked to the point of refusal, the more refractory timbers would receive but a relatively small amount of the solution injected, and still after the process of withdrawal had been finished, the total amount of creosote left in the ties might meet the desired result in the way of a general average of material left in the timber, notwithstanding the deficient penetration of the more refractory ones. In other words, more than the specified amount of creosote would remain in the ties that were easily penetrable and less than the amount in the refractory ones. In fact this was the explanation offered by some to account for the shallow penetration that had been observed in many of the hardwood ties that had been treated by a so-called "empty-cell" process. In defense of this "empty-cell" method some of those interested in the same denied that such could be the case, as they insisted that in the working of the said process the creosote was first injected to the point of the refusal of the timber to take any more,

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before the withdrawal of the creosote was attempted. Those who had not practiced the grouping of timbers also laid claim to the same thing—none of them would admit having stopped the treatment short of the point of maximum absorption. It was these persons—the "empty-cell" workers and those who did not practice grouping—by whom it was "generally conceded that nothing short of treatment of the timber to total refusal can be satisfactory." To admit anything else than this would be equivalent to admission of a defect in the method or process of the treatment which had been in practice.

So far as the ordinary or "full-cell" process of creosoting is concerned, one of two things must be admitted: either a large amount of creosote could be absorbed by some of the hardwood timbers that are being treated, but it is not so absorbed by reason of cutting the process short before the point of refusal is reached; or else the pressures used are insufficient to force the solution into the timber. The fact stands that, whichever way those who argue the point will have it, large numbers of hardwood ties are being and have been treated with the result of but shallow penetration.

Our correspondent raises another point, which may possibly be discussed with some interest, where he says: "Many roads use more or less zinc chloride, not, I judge, because they think they are going to 'beat the time' of creosoting, but because they believe it a better business proposition."

It is a fact that some roads, or, at any rate, students of tie treatment officially connected with some of the roads, believe that the use of zinc chloride is a better business proposition than some of the modified creosote processes. In the first place, it is quite generally conceded, we have no hesitation in saying, that many of our hardwood timbers, and especially the oaks, are difficult of penetration by creosote, requiring heavy pressures and long application. Furthermore, we are assured, by undoubted authority, that these same timbers, under like conditions of pressure and time of application, are more readily penetrated by zinc chloride than by creosote.

If such is the fact, is it not a very important one to consider in this matter of tie preservation economy? As for efficiency of treatment, is there anything to be learned from practical results which makes an unfavorable showing for our oak ties that have been treated with zinc chloride, as compared with the same kind of timber treated with the partial creosoting process, whether of the "empty-cell" variety or of the full cell treatment cut short before the point of refusal is reached? So far as experience in this country is concerned we think not, and it rather looks as though some of those who were responsible for the substitution of one of these partial creosoting processes for zinc chloride, which was done so extensively five or six years ago, might have to take the defensive side of this question.

The first, or one of the first, roads in this country to treat oak ties was the Chicago & Eastern Illinois Railroad. On that road the treatment of red oak, black oak, and other inferior oaks, with zinc chloride, was

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begun in 1898 or 1899. From records begun in 1900, less than 2% of the ties treated in that year had been removed from the track in 1910, and of those treated previously there has, as yet, been no considerable deterioration; that is, nearly all of the ties are still quite sound and in good condition and give promise of further service for at least several years. We are also informed that like prospects for longevity of service is showing up for tamarack and other inferior softwood ties treated by zinc chloride by the Chicago & Northwestern Ry. at its Escanaba plant, as long as nine years ago.

Argument has been frequently offered that estimates of the life of treated ties were unreliable unless based upon actual knowledge derived from practical trial. A fact in this connection is that before there had been opportunity to fully determine the practical result of treating oak ties by zinc chloride, not a few railroad managements went over to the use of one or the other of the partial creosoting processes at an expense for treatment amounting to double that for zinc chloride. In the face of this fact some of these people have argued against the steaming of timber or the kiln drying of timber before treatment, because it would add a few cents to the cost of each tie so treated. Is there not, therefore, a spirit of inconsistency in the line of argument pursued by some of these persons who have changed to a partial creosoting process, at such a large advance over the cost of the zinc chloride treatment, without information of practical trial of these modifications of standard creosoting work to show what the efficiency thereof might be? If the zinc chloride treatment without the kiln drying of ties, when thoroughly done, can show such favorable results as are unmistakably in evidence, with both softwood and hardwood ties, why so much theoretical argument and discussion about the question of seeking to still improve this process by kiln drying, at a cost of a few cents per tie, especially when so many railroad officials have been willing to substitute something else, at double the cost, with no knowledge as to how long ties so treated would last.

(PUBLISHED IN THE RAILWAY AND ENGINEERING REVIEW, SEPTEMBER 7, 1912.)

August 28th, 1912.

Editor, Railway and Engineering Review,
Chicago, Ill.

Dear Sir—In your issue of August 17th, you publish a letter from Mr. Burkhalter, in which he undertakes to administer you a lecture on the ethics of the press and criticize your composition. I will not contend with him in point of composition. He is a scholar and, if I am truly informed, he writes Latin with almost as much purity as English. Suffer me, then, Mr. Editor, for I am a plain unlettered man, to imitate your style of discussing more than one question at a time, which suits my capacity, and to which, considering the readiness of Mr. Burkhalter's reply, he ought to have no objection.

Mr. Burkhalter seems to derive exceptional interest in my article of "Grouping of Timbers," as he acknowledges that he was the writer

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of the resolutions. In my letter I omitted to connect his name with the resolutions, for I did not think that they reflected much credit to him. He states that I did not print anything which was in principle unknown to the men who voted for the resolutions, that is to say, all of the members, according to his statement, knew that the variation in absorption ranged from two pounds to sixty pounds of oil per tie, whether they were separated according to species or not, and that the variation in absorption would be just the same whether each species of timber was treated separately or treated together. If the members distinctly understood this principle, as alleged by Mr. Burkhalter, it seems strange that they would have voted in favor of the resolutions. I do not think that really this principle was well understood, but on the contrary it was generally supposed by many that the variation was very small when each species of timber was treated separately. No results of experiments to determine this question had been published before, and I believe that some of the members voted for the resolutions without sufficient information and did not consider the matter of much importance. It was very unusual for the Association to pass such resolutions. At no time in the history of the organization had similar resolutions been adopted. They were sprung upon the Association by surprise and without discussion were hurriedly voted upon and adopted.

Mr. Burkhalter remarks, "His tabulation is on the 'Lowry Process,' which is expected to withdraw the surplus creosote; one might assume from it that more was withdrawn from some ties than from others, etc." Yes, and it would be purely an assumption on false premises. It has been clearly demonstrated time and again that the promoters of the Lowry Process cannot do what they claim. The claim is that they can withdraw from the wood any desired amount of oil by means of a "quick high vacuum," applied at the end of the treating operation. The proposition is most absurd, yet many people believe it. The oil is not drawn out by means of a vacuum, but it is forced out by the expansion of the air, which is compressed in the cells of the wood simultaneously with the injection of the fluid. The quantity of fluid that is expelled or oozes out after the pressure is released depends upon the amount (in volume, not in intensity) of air in the cells immediately before impregnation. The dryer and more porous the wood the greater will be the absorption and consequently the greater will be the rebound of the fluid after the pressure is released. And on the contrary the greener and denser the wood the smaller will be the absorption and rebound of the fluid. It is a well established fact that the amount of fluid expelled by the expansion of the air, which is compressed simultaneously with the fluid, is directly proportional to the amount of fluid injected in the wood, and neither an initial pressure, as in the Rueping process, or a final vacuum, as in the Lowry process, can materially change the natural phenomenon which always takes place when timber is treated under pressure. The application of a final vacuum to dry ties after treatment while still dripping in the impregnating retort was practised in this country long before Mr. Lowry was in the treating business. It is a common practice to apply a final vacuum at nearly all of the plants

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in this country. No matter how quickly the vacuum is applied or number of inches obtained, the vacuum can only assist the escape of the compressed air, which brings out with it some of the fluid in the wood, thus shortening the time of dripping and hastening the drying of the ties. We are not sure but what Mr. Burkhalter applies a final vacuum for hastening the drying of the ties and we do not think that he pays the Lowry people a royalty for the privilege. Therefore, he must be aware that the amount of oil or fluid which rebounds after release of the pressure is unaffected by the application of a vacuum and consequently it is not possible to withdraw any desired amount of oil by means of a final vacuum. Just so much will come out by natural process and no more. Mr. Burkhalter simply repeats what he has heard others say and without positive knowledge of his own. I would suggest that he conduct a series of experiments, similar to those which I have presented recently, and prove or disprove my contention, that the variation of absorption is just as much when the ties are segregated into groups by species, as when the several species are treated together; then if I am right what is the sense or necessity of separating them to secure greater uniformity of absorption in treatment? In many instances it is found necessary to separate ties into classes or groups. For example, white oak ties are usually separated from treatment ties, cull ties from good ties; eight foot ties from eight and one-half foot ties; sawed ties from hewed ties, and hardwood ties from softwood ties. Such separation is for commercial economy and not for treating efficiency. Designers of treating plants should bear this difference in mind and arrange the yard tracks and equip the plant with such appliances and facilities as will enable the separating of ties into as may groups as may be desired in the most economical manner, upon arrival at the treating plant.

Mr. Burkhalter refers to treating of bull pine and red fir ties. These species of timber do not grow in Pennsylvania, nor does he treat any such timber at Bradford. Would it not be better for him to tell us something about his method and experience in treating red oak, beech, maple and possibly other kinds of wood, with creosote oil? We would suggest that he tell us about how many ties are treated annually for the B. R. & P. Ry., who own the treating plant; average amount of oil absorbed per tie; range or variation in absorption; average cost of ties delivered at treating plant; cost of treating ties; average length of time each species is carried in stock for air seasoning and average or mean life he expects to obtain. Such information would be of value for determining the relative economy of treating ties by various methods and with different antiseptics and incidentally might reveal to him the possibility of improving his methods, that would result beneficially to the railroad by whom he is employed. His letter contains nothing to enlighten the user of treated material. No idea is suggested. It is purely negative and obstructive. A person is entitled to some credit for suggesting an idea even if it should in the end prove erroneous, for he would have made an effort to contribute something for the advancement of the art of

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timber treating. But the man who simply devotes his time to opposing and obstructing ideas proposed by others, thereby clogs the wheels of progress.

Mr. Burkhalter will permit me to express thanks for the honor of his correspondence. It has afforded an opportunity to give publicity to some facts regarding certain methods employed for treating ties and timbers. Perhaps he and his friends rejoiced when the Association adopted the resolutions and supposed that they would bury the question in a profound and uninterrupted silence. But alas, they were mistaken.

W. F. GOLTRA.

TREATING PROCESSES.

Receiving frequent inquiries in regard to the value of wood preservation and processes of treatment, I have deemed it advisable to give publicity to some facts in regard to this subject. It will be my aim to discuss freely the principles underlying timber treating and processes employed for that purpose, in a fair spirit and without fear or favor. The literature dealing with this subject is bewildering and it is not my present intention to add to this already voluminous literature, but it is my desire to present some facts that have come to my notice and which are not generally known, or easily accessible.

Treating of timber has been practised since the middle of the Seventeenth Century and many processes have been tried, but most of them have not survived, either through cost of material, difficulty in their application, or other objectionable features. Maxime Paulet, a French writer (Paris, 1874), mentions 174 in all and those which have survived can be counted on the fingers of one hand. Of these processes many more would no doubt prove effective provided they could be carefully and economically applied. All of these processes are of foreign origin. American inventive spirit has added about twenty more, two of which will be made the theme of this article; these are known as the Lowry Creosoting Process and the Rueping Process, both patented and sometimes referred to as "empty-cell" processes.

LOWRY CREOSOTING PROCESS.

Mr. C. B. Lowry, of Lexington, Ky., was a part owner of an old treating plant at Slidell, La., which was acquired from the N. O. & N. E. R. R., sometime in the Fall of 1902. Previous to this he was engaged in the lumber business for several years. In February, 1904, Mr. Lowry entered into an agreement with the Cleveland, Cincinnati, Chicago & St. Louis Ry. Co., to treat with creosote oil 400,000 ties per annum, for five years. Mr. Lowry was killed in a railroad accident near New Orleans in November, 1908, and at the time was General Manager of the American Creosoting Company.

The contract with the C. C. C. & St. L. Ry. Co. required that a plant be built on their lines, at any point that the railroad company might

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designate. It was decided to locate it at Shirley, Ind. The plant was completed and put into operation about May 1st, 1905, treating during that year approximately 185,000 ties. The following specifications regarding method of treatment embodied in this contract read as follows:

Section 12. "Ties to be placed in air-tight cylinders and door closed and a vacuum of approximately twenty (20) inches of mercury created, with the interior of the cylinder kept as hot as possible, by heater coils. Sufficient oil to be then admitted to entirely cover the ties, but not to fill the cylinder. The temperature of the oil to be then raised to about 200 degrees F. and the vacuum pump kept in operation, so as to remove the vaporized moisture as fast as formed, and continued until a vacuum of twenty (20) inches or more can be maintained with the temperature at approximately 200 degrees F. When it is established that all the water is removed from the ties, as above, the cylinder to be completely filled with oil and the pressure pump started and operated until, by the established system of measurements, the ties have absorbed two-and-one-half gallons of oil per tie. The treatment process to be then stopped, the oil to be removed from the cylinder and the ties to be immediately withdrawn."

In November, 1905, Mr. Lowry made a supplemental contract by which the term was extended another five years or until January 1st, 1914, the quantity increased to 550,000 ties annually and the contract was assigned to the Columbia Creosoting Company, which was afterwards succeeded by the American Creosoting Company. The specifications were amended to read as follows:

Section 3. "That said first party (Col. Creo. Co.) shall hereafter at the request of said second party (C. C. C. & St. L. Ry.) treat cross ties to conform to the above mentioned specifications as to width and thickness, but as long as eight and one-half (8½) feet without any additional charge for such additional length, and that in so treating said ties eight and one-half (8½) feet in length it will inject at least four gallons of creosote oil provided for by said agreement per tie, and that of said four gallons of creosote oil per tie so much shall be withdrawn by vacuum as to leave an average of not less than two and one-half (2½) gallons of oil in each and every tie."

When a copy of the supplemental contract was received by the Treating Inspector at Shirley, Ind., he wrote the Superintendent of Maintenance of Way for information. The letter reads as follows:

Shirley, Ind., March 22, 1906.

A. L. Kuehn, Supt. Maintenance,
Cincinnati, O.

"Referring to copies of contract with Col. Creo. Co., received today. For my information will you kindly advise if Section No. 3, of the subsequent agreement, dated Nov. 6th, 1905, revokes Sec. No. 12 of the original contract with Mr. Lowry, dated Feb. 23rd, 1904. The method now in vogue is to place the ties in the retort, fill the retort with oil at 160 degrees F. and immediately put on the pressure until about four gallons are injected into the tie. The oil then drawn off the ties and the retort subjected to a vocuum of about 25 inches, until the amount of oil remaining in the tie is about two and one-half gallons, which completes the operation." Yours truly,

ROBT. H. MOORE.

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Cincinnati, Ohio, March 24, 1906.

Mr. R. H. Moore,

Answering your letter of the 22nd. Clause 3 of the supplementary contract with the Columbia Creosoting Co., dated November 6th, 1905, states that the revised manner of treatment shall be at the request of the second party. It is our request that ties be treated in the manner as stated in Clause 3, so that Clause 3 amends Clause 12 of the previous contract.

Yours truly,

(Signed) A. L. KUEHN.

It will be observed that the treating operation from the beginning was not in accordance with the specifications given in the original contract and from our own knowledge can state that the ties have been treated in the manner above described by the inspector ever since and no change was made in the method of treatment when the supplemental contract was made with the railroad company.

In September, 1906, Mr. Lowry obtained a patent for a process, which he claimed he had invented. The operation of the "Lowry Process," as it is generally understood and covered by Letters Patent No. 831,450, is as follows:

"The ties are run into a retort or cylinder, preferably on cars, and thereupon the doors of the retort are closed, so as to make the latter perfectly air-tight. The retort is then FILLED with oil of the kind with which the ties are to be treated, and pressure is applied by forcing more oil into the retort by aid of pumps.. This is continued until the ties are THOROUGHLY and COMPLETELY SATURATED, the oil entering the pores and cells and THOROUGHLY IMPREGNATING the wood. This requires about four and one-half gallons of oil for each tie, if the latter be of oak or other hardwood, and about seven gallons if of pine."

"After the stated quantity of oil has been forced into the retort the pumps are stopped and all free oil is quickly withdrawn through suitable valves. The latter are then closed and a quick high vacuum is produced, representing from about twenty-five to twenty-seven inches of mercury. This vacuum is maintained for from one and one-half to two hours, by which time most of the oil in the cells and pores of the timber is withdrawn. The quantity of the oil then remaining in each tie after this step is completed is about two and one-half gallons ALL OF WHICH IS THOROUGHLY ABSORBED AND TAKEN UP BY THE FIBRES. This saving is made possible by the quick production of the vacuum, thereby enabling the oil to be withdrawn from the cells or pores of the wood before the air can escape through the oil forced thereinto."

"The herein described process of preserving wood, consisting of SATURATING THE WOOD with creosote oil under pressure while ENTIRELY SUBMERGED, then removing all free oil, and then immediately subjecting the wood to the action of a vacuum to withdraw MOST of the oil from the pores and cells thereof."

Lowry claimed that by injecting a large quantity of oil and then withdrawing a large portion of it by means of a final vacuum he could obtain a deeper penetration, with less quantity of oil, than would otherwise be obtained by any other process. In treating ties or timber there is a natural phenomenon which takes place, that is, upon releasing the oil pressure, the compressed air in the wood cells expels more or less of

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the fluid, depending upon the quantity of air in the cells, which in turn depends upon the dryness, character and condition of the wood. The expelling of the fluid is due to the expansion of the air in returning to its normal state. It has long been known that a greater quantity of fluid is injected into the wood than actually remains in it, and the difference between the amount injected into the wood and that which is expelled by expansion of the air, is what Mr. Lowry supposed he was withdrawing from the wood by means of a final vacuum. A final vacuum was applied in treatment of material many years before Mr. Lowry obtained his patent and it is a common practice everywhere to apply a final vacuum, to assist in drying the ties. He succeeded in making a good many people believe that he had discovered a new process and that he had made a wonderful addition to the art of wood preservation.

Contracts with various railroads were made in quick succession. The following is a list of roads who made contracts for a term of years for treatment of a minimum number of cross ties by the Lowry process, together with date plant was completed and put in operation, location and minimum number of ties that shall be treated annually:

Road.	Location.	Year Built.	Min. Treated.
C. C. C. & St. L. Ry.	Shirley, Ind.	1905	550,000
Chicago, Indianapolis & Louisville Ry.	Bloomington, Ind.	1907	250,000
Rock Island-Frisco Lines	Kansas City, Mo.	1907	750,000
" "	Springfield, Mo.	1907	750,000
" "	Hugo, Okla.	1907	750,000
" "	Marion, Ill.	1907	750,000
Northern Pacific R. R.	Brainard, Minn.	1907	750,000
" " "	Paradise, Mont.	1907	750,000
L.S.& M.S.Ry.and Mich.Central R.R.	Toledo, Ohio.	1909	1,200,000
Delaware, Lackawanna & Western Ry.	Patterson, N. J.	1909	500,000
Lehigh Valley Ry	Bound Brook, N. J.	1909	400,000
Kansas City Southern Ry International & Great Northern Ry. Texas Pacific Ry	Shreveport, La.	1910	750,000
N. Y. C. & H. R. R. R.	Rome, N. Y.	1911	750,000
	Total		8,900,000

In addition to the above minimum quantities which the railroads are obliged to have treated annually, whether they are needed or not, large quantities of ties are being treated for other roads at some of these plants. The United States Forest Service reports that in 1910 the total number of treated cross ties for steam and electric railroads was 30,544,000, so that at the present time about one-third of the ties used in this country are treated by the Lowry creosoting process. In all of the above contracts, so far as we know, the treating company furnishes the oil and receives from thirty to forty cents per tie on the basis of leaving an average of two and one-half gallons of oil in each tie. The railroad companies furnish free transportation of oil and fuel over their own lines and assume cost of unloading and stacking of ties in the yard. The price of creosote oil is about seven cents per gallon, depend-

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ing upon the point of delivery. The cost of labor, fuel supplies, repairs, depreciation and superintendence for ties treated by this method is about 7½c per tie. The standard and narrow gauge tracks and platforms have been built by the railroad companies. The cost in some instances is upwards of $100,000.00. In the annual reports of the New York Central & Hudson River Railroad Company for years 1910 and 1911, I observe that the railroad company expended $123,037.33 for new creosoting plant at Rome, N. Y., presumably all for tracks and platforms. This represents about one-half of the entire cost of the treating plant, exclusive of land.

RUEPING PROCESS.

The first noteworthy mention we can find of the Rueping process is in a report submitted by Mr. J. W. Kendrick, formerly Vice-President of the Atchison, Topeka & Santa Fe Railroad, to the International Railway Congress, January, 1905. The report reads as follows:

"Recently, a new plan for creosoting ties, called the Rueping process, has been brought into notice and tests have been made on a small scale at Perth Amboy, N. J., in order to show what could be done. The process requires seasoned wood to begin with, the material being placed in a closed cylinder and air forced in under pressure, about 75 lbs. to the square inch. Creosote is then forced in under a higher pressure, which is increased to 200 pounds per square inch, and continued until the timber has absorbed all it will take. The pressure is then removed and the creosote remaining in the cylinder forced back, when the compressed air in the wood expands and forces out the surplus creosote remaining in the cells of the wood; the theory being that the wood cells and fibre are heavily and sufficiently coated with creosote to preserve the wood, and that the remainder of the creosote, which would otherwise be left in the cells, is not necessary for preservation. As the usual pressure used in wood preserving plants in this country does not exceed, say, 110 lb., in ordinary work, it would be necessary to replace a number of cylinders now in use, if so high a pressure were necessary, but an experiment made recently shows that a very good penetration can be obtained in loblolly and shortleaf Texas pine, using a pressure of only 105 lbs., leaving in the wood about five pounds to the cubic foot. Whether this small amount with no other preservative as an auxiliary is sufficient to accomplish the desired purpose remains yet to be proved, as are also some other points of equal importance. If it proves to be satisfactory, it will be especially useful in those sections of the country where the zinc chloride is apt to leach out, that is in all but arid and simi-arid zones. A test on a commercial scale is being made at Somerville, Texas, and if the results after full investigation and trial are satisfactory it will be a valuable addition to the processes for wood preservation."

The patent covering the Rueping process of impregnating was issued under Patent No. 709,799 to Max Rueping, Charlottenburg, Germany, dated Sept. 23rd, 1902.

CLAIM. A method of impregnating wood and other porous material in subjecting the material to be impregnated before its treatment with the impregnating liquid to a strong air or gas pressure, so that the cells, pores or cavities are first filled with highly compressed air or gas, which, after the material has been treated with impregnating liquid under still greater pressure, presses by its expansion when the pressure is cut off

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and if desired a vacuum created the excess of impregnating liquid wholly or partly out of the cells, pores or cavities of the material, substantially as described.

This patent was re-issued to Max Rueping and assigned to Hulsberg & Co., of Frankfort, Germany, October 22nd, 1907, under Patent No. 12,707.

CLAIM 1. The method of impregnating wood and other porous material, which consists in subjecting the material to be treated to a strong gas pressure in a closed vessel, whereby the cells, pores or cavities of said material are filled with highly compressed gas, then subjecting the material to the action of an impregnating liquid at a still higher pressure and then reducing the pressure, whereupon the compressed gas presses the excess of impregnating liquid out of the cells, pores or cavities of the material, substantially as described.

2. The method of impregnating wood and other porous material which consists in subjecting the material to be treated to a strong gas pressure in a closed vessel, whereby the cells, pores or cavities of said material are filled with highly compressed gas, then subjecting the material to the action of an impregnating liquid at a still higher pressure and then creating a vacuum in the vessel whereby the compressed gas presses the excess of impregnating liquid out of the cells, pores or cavities of the material, substantially as described.

The Rueping people were not quite as successful as the Lowry people in introducing their process on railroads. However, they succeeded in having their method adopted on the following roads:

Road.	Location.	Year Built.	No. Treated.
A. T. & S. F. Ry	Somerville, Tex.	1906	1,200,000
Illinois Central	Carbondale, Ill.	1903\	2,000,000
Illinois Central	Grenada, Miss.	1904/	
C. R. I. & P. Ry	Argenta, Ark.	1908	1,000,000
M. K. & T. Ry	Dennison, Texas.	1909	1,000,000
El Paso & Southwestern	Alamogorda, N. M.	1902	200,000
		Total	5,400,000

The Rueping process was adopted by the Illinois Central Railroad at the Carbondale and Grenada plants, owned by the Ayer & Lord Tie Company, in 1907, and by the C. R. I. & P. at the Argenta plant, also owned by the Ayer & Lord Tie Company, in 1908. Previous to this all ties for these roads were treated by the Burnett or zinc chloride process. The M. K. & T. adopted the process when their plant at Dennison, Tex., was rebuilt in 1909. The El Paso & Southwestern, if we are correctly informed, changed from zinc chloride treatment to Rueping process in 1906 or 1907, about the same time the A. T. & S. F. made the change on their lines. The quantity treated annually given above are estimated, as we have no means of getting definite information regarding number of ties treated for various railroads, nor have I been able to find out definitely what railroads are paying a royalty for use of this process. Unlike the Lowry people, the Rueping people do not own or operate any plants, but simply license the railroads and treating companies to use their patent and for which I understand they charge a royalty of one cent per tie.

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LOWRY vs. RUEPING.

Soon after Mr. Lowry obtained a patent on his process, in Sept., 1906, which consisted in simply applying a final vacuum to withdraw oil injected into the wood, Mr. G. A. Lembecke, of New York, brought suit for infringement of patent issued to Rueping in 1902. The case was tried before a court and decided in favor of Lowry. An appeal was taken and the following decision appears in the Official Gazette of the United States Patent Office, July, 1911.

COMMISSIONER'S DECISIONS.

LOWRY vs RUEPING.

Decided January 25th, 1910.

Interference—Priority.

Priority of invention, Held properly awarded to Lowry. Appeal from Examiner in Chief.

WOOD IMPREGNATION.

Mr. J. Nota McGill, for Lowry.
Messrs. Wilkinson, Fisher & Witherspoon for Rueping.
Billings, First Assistant Commissioner.

This is an appeal by Rueping from the decision of the Examiners in Chief affirming the decision of the Examiner of Interferences awarding priority of invention to Lowry upon the following issue:

"The herein described process of preserving wood, consisting in saturating the wood with creosote oil under pressure while entirely submerged, then removing all free oil, and then immediately subjecting the wood to the action of a vacuum to withdraw most of the oil from the pores and cells thereof."

As appears from this issue the invention is a process for the preservation of timber and is designed particularly for use on railway ties. It differs from a process for the same purpose patented by Rueping in 1902 in omitting an initial air pressure used by him. Both the patented Rueping process and the process in issue differ from the prior art in withdrawing a large per cent, of the oil which has been previously forced into the wood.

Lowry is a patentee, and the claim was adopted by Rueping from the patent after its issuance. Lowry derives no benefit in this proceeding, however, by virtue of his patent, since Rueping's application was filed before Lowry's.

Rueping in his preliminary statement alleges that he made the invention in Germany and applied for certain foreign patents in September, 1904, and that knowledge of the patent was introduced into this country in September, 1904, in connection with the preparation of the application involved in this interference. It was held by the tribunals below that these facts had not been proved and that Rueping is entitled to no date earlier than the 10th of October, 1904, the date of filing his domestic application. The holding is accepted on behalf of Rueping on this appeal, as appears from the following in Rueping's brief, pages 1 and 2:

"Rueping is a foreigner, and, for the purpose of this discussion, his available date of invention and reduction to practice may be taken to be October 10th, 1904, the day upon which his application was filed in this country."

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Whether Rueping be given a date in September or October of the year 1904, however, in no way affects the results, as will appear hereinafter. Lowry alleges in his preliminary statement that he conceived the invention in September, 1902, disclosed it to others and reduced it to practice in May, 1903, and that it was thereafter successfully practiced in December, 1903, October, 1904, and March, 1905, and has been used continuously since the latter date.

There is no testimony offered in corroboration of Lowry's statements that he conceived the invention or reduced it to practice in September, 1902, or May, 1903, and neither of the tribunals below have given him credit for any date earlier than December, 1903. The Examiner of Interferences found the testimony showed that Lowry reduced the invention to practice in December, 1903, at the Riverside Shops of the Big Four Railroad, near Cincinnati, and was entitled to prevail on that ground. He also held that Lowry reduced the invention to practice at St. Louis in October and November, 1904, and that he was showing such diligence in perfecting the invention at and after the time Rueping entered the field as entitles him to an award of priority, though the Riverside reduction to practice be disregarded. The Examiner in Chief did not find that the operations at Riverside constituted a reduction to practice, but held that Lowry conceived and disclosed the invention prior to the time Rueping entered the field and reduced it to practice in October and November, 1904, at St. Louis, and again at Shirley, Indiana, in March, 1905, and that he showed proper diligence in perfecting the invention, whichever of these demonstrations is relied upon.

It is the contention of Rueping on this appeal that Lowry has not shown a reduction to practice prior to March, 1905, when the Shirley plant was first operated, and that there is no showing of diligence connecting this with a conception prior to October 10th, 1904, such as would entitle Lowry to prevail.

That Lowry constructed an experimental plant at Riverside in December, 1903, and there tried out his invention is amply proved by the testimony offered. Lowry testifies that he performed there all the steps called for in the claim in issue, though it is not shown in direct testimony how successfully the last step of the process accomplished its function. Keegan corroborates Lowry as to the use of the process at Riverside in all but the date, which is otherwise satisfactorily fixed. His testimony is in narrative form and indicates an independent recollection of the events. He describes every step of the process performed there, and as to its success he testifies from his personal observation that when the ties were cut up they were found "wet with oil all the way through." Lowry testifies (Q.37) that the process as a whole was identical with that practiced later at the Shirley plant, and Keegan states that when the ties were piled up after the process some dripped oil and some did not. This would be the expected result if the third step—the application of the vacuum—was successful in withdrawing the surplus oil, inasmuch as some of the ties were there treated by this process and some by a process in which no oil was withdrawn. Furthermore, it is shown that a few months later Lowry was told of the Rueping patented process as practiced at Perth Amboy, in which most of the oil was withdrawn by vacuum, he immediately asserted that he could do and had done at Riverside the same thing, without the preliminary air pressure, and took Clark, an official of the Big Four Railroad, there for the purpose of proving his statement. He found that the apparatus at Riverside had been dismantled, without his knowledge, and therefore the demonstration was not made; but the circumstances add great force to Lowry's assertions that his process was successfully performed at Riverside and that the operation there under this process was identical with the operation

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subsequently at the Shirley plant, when the excess oil was unquestionably withdrawn by vacuum.

It has been suggested that the success of the process cannot be held to have been demonstrated at Riverside in the absence of records of direct testimony showing how much oil was withdrawn. The absence of records is satisfactorily explained by the fact that the purpose of the tests at Riverside was primarily to satisfy Kittridge, the chief engineer of the Big Four Railroad, that the hardwood timber available along the right of way of that road could be creosoted in the usual way, and sections of ties themselves were submitted to Kittridge as the best evidence of the results. The success of the process should not be made to depend upon the extraction of any given amount of oil from the tie, for the claim in issue does not call for the withdrawal of any specified proportion.

It is further contended in behalf of Rueping that if Lowry had known of the invention in December, 1903, or had then successfully performed the process, he would have disclosed it at the time to Kittridge, with whom he was negotiating a contract for creosoting ties, and have urged its adoption. His silence, however, is satisfactorily explained by the fact that the ultimate value of the process was not then and is not now positively assured and that it would have been unwise for him to urge or discuss such an unproved process while attempting to close a contract of vital importance to himself and one which the testimony shows was the first of its kind in this country.

Upon the whole it seems to me satisfactorily established that all the operations constituting the process in issue were practiced at Riverside, and although the testimony as to the effect of the last step—the withdrawal of the oil—is somewhat circumstantial, it is believed sufficient to show that Lowry fully reduced the invention to practice at that time, which, being long prior to Rueping's filing date, entitles him to an award of priority.

It is believed, however, that Lowry must prevail, even if the operations at Riverside be disregarded. Passing to a consideration of the latter alleged practice of the invention by Lowry, it is found that there is abundant testimony, including that already discussed, to show that he had a conception of the invention prior to the time Rueping entered the field. Barnard, among others, who prepared Lowry's plans for the Shirley plant, states that the invention was disclosed to him by Lowry in March or in the early part of April, 1904. (X-Qs. 36 and 37; R. D. Q. 38). It is also well established that the process was actually performed under Lowry's direction both at St. Louis in October and November, 1904, and at Shirley, Ind., in March, 1905, and subsequently. The testimony showing these facts is fully discussed in the decisions below and need not be reviewed here in detail.

An objection is urged in behalf of Rueping, however, against holding the St. Louis operations as a reduction to practice, which may be referred to. He asserts that the reports of the runs there made, copies of which are in evidence, show that the tests were of a purely experimental character and so could not constitute a reduction to practice. This contention is based upon calculations set out at length in Rueping's brief tending to show that—

> Less than 4% of the hardwood ties treated at St. Louis were treated in accordance with the specifications of his patent—

and that of the pine ties—

> Less than 19% come within 10% either way of the two and half gallons he specified.

This argument loses force, however, in view of the fact, above pointed out, that the issue is not limited to the injection or withdrawal

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of any stated quantity of oil. If the quantities named in Lowry's specifications as an illustration were material, Rueping would have no standing in this interference, for his application is absolutely silent as to the amount to be put in or taken out. Furthermore, this very summary of the results is an effectual admission that the process was, in fact, successfully performed, since in a number of instances the record of the runs correspond substantially with the example cited in Lowry's specifications. Considering the various kinds and conditions of timber treated at that time it would be expected that some considerable variations would be shown in the results, especially in view of the fact that it was not the purpose there to produce a uniform article of commerce.

Since both the St. Louis and Shirley reductions to practice were subsequent to Rueping's date of October 10, 1904, Lowry's diligence becomes material if he is to rely upon either.

At the time Rueping appeared on the field Lowry had succeeded in securing the necessary capital for the construction of the Shirley plant, had arranged with the Allis-Chalmers Co. for the making of the necessary plans, which were begun in February or March, 1904, and finished towards the end of the summer, and had invested all of his own available money to bind a five year contract for oil. He had further during the summer of 1904 made arrangements with von Schrenk to conduct a demonstration at the St. Louis Exposition in accordance with his invention and had secured oil and apparatus for his use there.

The first retort for the Shirley plant was installed about October, 1904; but the plant was not sufficiently completed for operation until March, 1905, when runs were made in accordance with the process in issue. The building of the plant was a large enterprise, requiring the expenditure of something over $100,000.00, and it appears that Lowry was devoting his entire time to the project. He had during this period no other business. The time consumed in the completion cannot be considered unreasonable, considering the magnitude of the undertaking. It has been objected by Rueping that the construction of the Shirley plant could not be considered diligence, because Lowry was under contract to creosote ties there under another process. It has been shown, however, that Lowry had in mind from the first the practice of his process at this plant and had the retorts designed especially to facilitate the rapid withdrawal of the free oil to permit the immediate application of the vacuum—a feature peculiar to the process in issue. It also appears from the testimony that Kittridge had given his consent to the use of Lowry's process on Big Four ties, prior to the completion of the plant. It can hardly be urged with reason that Lowry should have first constructed a smaller plant to test his invention, which might have been completed sooner, especially in view of the arrangements for the St. Louis tests, which occurred very shortly after Rueping entered the field.

It must be held, therefore, that Lowry was exercising due diligence in reducing the invention to practice both at St. Louis and at Shirley, and the diligence covers a period beginning some time prior to the appearance of Rueping in the field.

Lowry is accordingly entitled to an award of priority whether his reduction to practice be accepted as that at Riverside in December, 1903, at St. Louis in October and November, 1904, or at Shirley in March, 1905.

The decisions of the Examiners-in-Chief is affirmed.

No doubt the above decision is very amusing to anyone who has any knowledge of timber treating. Note how everything seemed to be

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"satisfactorily explained." It is queer how the experimental plant at Riverside (a suburb of Cincinnati, Ohio) disappeared so quickly. We learn that the man Keegan referred to in the decree was a section foreman and "Clark an official of the Big Four" was probably Mr. C. B. Clark, employed in the Operating Department as a Bridge Engineer. This man has not been in the service of the C. C. C. & St. L. Ry. in the past six or seven years and his whereabouts are unknown.

The Rueping process as well as the Lowry process are easily susceptible to proof or disproof by experiment, but their exponents depend upon plausible arguments in their favor and upon claims of what these processes will accomplish and rely upon inducing their prospective customer to have implicit faith in their statements. Faith is a beautiful thing. The dictionary defines faith as "the assent of mind to the truth of what is declared by another." Mark Twain defines it in a better way: "as the ability to believe that which you know to be false." Credulity has been one of the weaknesses of mankind since the dawn of time, but let us be charitable even to the Missourian, who asks, like a child, to be shown, and in his ignorance thinks it is wisdom.

The Rueping process depends on an initial air pressure of fifty pounds or more, in order to compress the air in the cells before entrance of the fluid, and their exponents labor under the mistaken idea that it will expel a greater quantity of antiseptic upon releasing the pressure. The exponents of this process pretend that they get as deep a penetration with five pounds of oil as could be obtained with ten pounds by any other process which omits the initial pressure. Experiments have clearly demonstrated that nothing of the sort is accomplished by an initial pressure and the burden of proof of the claim is upon the patentee, and the sooner these people get the idea out of their heads that the application of an initial air pressure will diminish the quantity of antiseptic necessary to thoroughly impregnate the timber, the sooner we will have an age of reason in wood treating business.

EFFECT OF AIR IN WOOD UPON ITS TREATMENT.

In an address made by Mr. F. H. Weiss, Assistant Director, Forest Product Laboratory, Madison, Wis., delivered before the American Wood Preservers' Association in January, 1912, he clearly indicated the effect of air in wood upon its treatment. We reproduce his diagram, Fig. 2, and quote his remarks upon this question, which were as follows:

"The three curves in Fig. 16, representing some preliminary work we have been conducting, illustrate this point. These results, gentlemen, are not final; they are yet purely preliminary, but we are going into this subject more thoroughly. Notice the curve where we use no preliminary vacuum. When the oil ran into the cylinder it dropped in temperature, but before we applied pressure we raised the temperature of

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the oil to 180 deg. F. This took us a little over five minutes. Then we applied 150 lbs. oil pressure to the square inch and held it there until we got an absorption of 12 lbs. per cubic foot. As soon as we got the maximum absorption of 12 lbs. per cubic foot we shut off the pump and opened the valve in the top of the retort. A rebound or "kick-back" immediately occurred. The sudden drop in the curve will show you the amount which thus flew out of the retort; it will also show the rate at which it

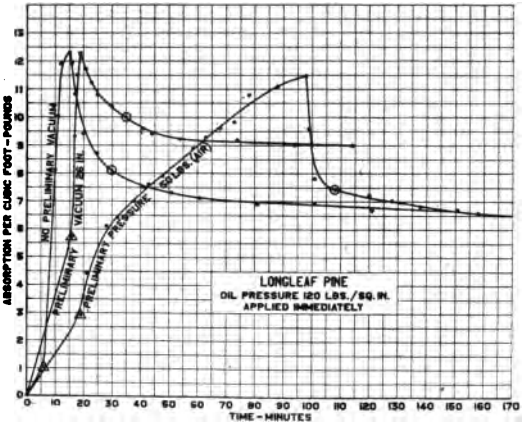

FIG. 2. THE EFFECT OF AIR IN WOOD UPON ITS TREATMENT.

came out. As soon as the oil stopped coming out of the top of retort we drained the cylinder. As soon as the cylinder was empty we let the wood remain in the cylinder and kept weighing the drip from time to time. The gradual fall in the curve will show you the drip. In other words, without the use of any preliminary vacuum we pumped the oil direct into the wood and then released the pressure. Deducting the "kick-back" and drip, although there was originally about 12 lbs. of oil per cubic foot forced into the wood, at the end of the treatment there remained slightly less than seven pounds.

"In the second test we used a preliminary vacuum, which, of course, took some of the air out of the wood. We argued if we took the air out of the wood, the oil ought to go in quicker, and less of it ought to come out on the release of the oil pressure. Let us see what happened. In the first place, the cylinder, after loading with wood, was under a vacuum of 26 inches. When the oil ran into it the temperature of the

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oil dropped further than it did in the first test, because the cylinder was colder. It took about 15 minutes to heat the oil to 180 deg. F. We then applied pressure in exactly the same way we did before until we got an absorption of approximately the same amount. You will notice how very quickly the oil went into the wood. It took less than five minutes. After we got the desired absorption of about 12 lbs. per cubic foot, we opened the valve at the top of the cylinder as was done in the first test, and a "kick-back" of oil occurred, but it was not nearly as great as in test number one. Keeping the temperature, of course, the same, the retort was drained and the drip collected. By using the preliminary vacuum, therefore, air was taken from the wood and apparently more oil remained in the wood after treatment.

"Then we tried one other test. We first filled the cylinder full of compressed air under fifty pounds pressure, and, without changing the pressure, pumped in the creosote. The pressure on the oil was then raised to 160 lbs. and the pump kept going until an absorption of 12 lbs. per cubic foot was obtained. Please compare the length of time it took to get the absorption in this case compared with the other two. It took one hundred minutes, five times as long as before, because we were pumping against an air pressure in the wood. After the maximum absorption was reached the pressure as before was released. Notice the speed at which the oil came out. After no more came out of the top of the retort, we collected the drip.

"What I expected to get, but didn't get, was a larger rebound of preservative. I don't know why it was not. One theory is, if you take creosote and pump it into wood cells, supposing that the air in each individual cell is confined, and the creosote is being pumped against it, you get a mixture of creosote and air under pressure, and under this condition the creosote will absorb air analogous to the way in which carbon dioxide is absorbed by water in the manufacture of seltzer waters. As I have mentioned, these curves are only indicative but they indicated the effect air in wood has upon the rate with which the preservative can be forced into the wood, the amount that can be forced in and the amount that stays in. Further tests now being made will increase their value."

The results of these preliminary experiments, which of course should not be regarded as final, indicate that no greater quantity of oil is expelled by the application of an initial pressure than without it. Furthermore the indications are that the application of an initial pressure only serves to prolong the duration of the treatment. Therefore the method or process of applying an initial air pressure is worse than useless.

Mr. Weiss has, in my opinion, given the correct theory regarding the mixture of air and creosote under pressure.

We learn that for over two years previous to the date of the issue of the Rueping process patent, Col. T. H. Sampson, President of the New Orleans Wood Preserving Company of New Orleans, La., used air under compression in cylinders in treating timber. Col. Sampson states

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that he has records to substantiate his claims and when the opportunity required he had used the process without paying any royalty.

As to the quantity of oil that can be recovered by a "final vacuum," Mr. Weiss did not state. The Lowry people claim that they can withdraw from the wood any quantity of oil they desire by means of a "quick high vacuum," and that their method is a secret (?) process. The Rueping people claim that practically all of the oil expelled is due to the application of an initial pressure of varying intensity, while the Lowry people claim it is all "sucked out" by means of a final vacuum and that the application of an initial pressure is unnecessary. In the patent case decision, Lowry asserted that "he could do and had done at Riverside the same thing (withdrawal of oil from wood) without the preliminary air pressure." In view of Mr. Weiss' experiments it is obvious that both are wrong and what fluid comes out of the timber after being injected into it is due to the expansion of the air that was compressed in the cells of the wood simultaneously with the injection of the fluid.

The claims made by parties in advocating the merits of these processes have been so broad that it is now generally believed that any desired amount of oil or fluid could be withdrawn from the wood by an initial pressure of varying intensity, or a final quick high vacuum. The quantity of fluid that is expelled or oozes out after the pressure is released depends entirely upon the amount of air in the cells, just before impregnation. If the wood is dry and porous it will absorb a large quantity of fluid and on the contrary if the wood is green and dense it will absorb only a small quantity of fluid and broadly speaking the amount of fluid expelled by the expansion of air, which is compressed simultaneously with the fluid, is directly proportional to the amount of fluid injected in the wood and neither an initial pressure or final vacuum can materially change the natural results. The application of a final vacuum to dry ties after treatment, while dripping in the impregnating retort, was practised in this country long before Mr. Lowry ever entered into the treating business. That is all that a vacuum can accomplish, for when it is applied to all surfaces of a tie, or piece of timber, which is filled with a solution, and containing no air, not a pound of fluid can be withdrawn, regardless of the number of inches of vacuum that can be obtained and the length of time it is held. But if there is some compressed air still left in the wood, the vacuum assists its escape, which brings out with it some of the fluid in the wood, thus shortening the time of dripping and hastening the drying of the wood.

FULL-CELL AND EMPTY-CELL PROCESSES.

The Rueping and Lowry processes have been exploited as "empty-cell" processes, as distinguished from "full-cell" processes. From the foregoing remarks it must be manifest that no such distinction can exist. The original Bethell process, invented in 1838, is as much an "empty-cell" process as either the Lowry or Rueping processes and conversely

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the Lowry and Rueping processes are as much "full-cell" processes as the Bethell process. There cannot possibly be any distinction between these several processes, because the expulsion of the liquid by the expansion of air in the wood when the fluid pressure is released occurs the same in all of them. The advocates of these two processes have invented a lot of awe-inspiring words and phrases, such as "full-cell," "empty-cell," "coated-walls," "painted-walls," "coated-cells," "compressed air bubbles," "air-plugs," "quick high vacuum," "heavy and long pressure," and other imaginary words, intended to mystify, hoodwink and bamboozle the uninitiated.

W. F. GOLTRA.

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ON THE RELATIVE ECONOMY OF TREATING RAILROAD TIES WITH VARIOUS ANTISEPTICS AND DIFFERENT METHODS.

Three of the well-known processes for preserving timbers in this country are the following, namely:

1. Bethell process, creosote oil being the antiseptic.
2. Burnett process, chloride of zinc being the antiseptic.
3. Rutgers process, a mixture of creosote oil and chloride of zinc being the antiseptic.

The Rueping and the Lowry processes are modifications of the Bethell process, Wellhouse process is a modification of Burnett process by the addition of glue and tannin. The Card process is a modification of the Rutgers process.

BETHELL PROCESS OR CREOSOTING.

This process consists of impregnating the timber with hot creosote oil in a closed cylinder under pressure. It was invented in 1838 by John Bethell, who found that by forcing at least seven pounds of creosote oil into each cubic foot of timber the process was satisfactory for railroad ties and other railway work, but for marine work it was better to have not less than ten pounds per cubic foot. Since those early days experimenters have used from 10 to 20 lbs. of creosote oil per cubic foot. The Western Railway of France injects 48 lbs. per tie as a minimum, equivalent to 16 lbs. per cubic foot, as per the following note:

"On the Western Railway (France) the creosoting of the railway ties has been carried on for over 40 years. The first contract for creosoted ties was dated Sept. 10th, 1865. From that day until 1878 the beech ties were injected with 18 to 22 kilos (36.9 to 48.4 lbs.), and the results obtained were perfect. In 1889 the Western Railway Company

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exhibited some creosoted beech ties taken from the track after 25 years' service. At the present time ties of the same kind, dating back to 1870 and 1871, are in our tracks and are in perfect condition (25 to 26 years).

"In 1878 it was thought best, from motives of economy, to diminish the quantity of creosote injected, and until 1885 treatment was carried on with the injection of 12 to 15 kilos per tie (26.4 to 33 lbs.). The results of this decision were bad. At the end of three years' decay began in ties insufficiently injected, and after five years' service a considerable number had to be renewed. In consequence, injection was increased to 17 to 18 kilos (37.4 to 39.6 lbs.) the surplus creosote being paid for extra.

"To insure more perfect treatment, we concluded in 1897 to further increase the injection, and in 1902 formal instructions were issued to inject 22 kilos (48.4 lbs.) as a minimum.

"We may now say that all the ties insufficiently injected from 1878 to 1885 have been replaced, because of premature decay, after ten to twelve years. Since 1885, on the other hand, results have been good, and we are certain that the ties delivered since 1897 will resist the action of decay.

"To sum up, when the injection of beech ties is performed by this 'vacuum and pressure' process, experience has taught us that, to obtain good treatment, we must inject an average of 22 kilos (48.4 lbs.) of creosote per tie. This average corresponds to the dose of liquid required to impregnate the wood to a depth sufficient to preserve the whole of the tie against decay. It is possible, however, that this last result may be attained by other processes which permit the retention in the wood of a smaller quantity of creosote, after pushing the injection to refusal, or say, 35 to 40 kilos (77 to 88 lbs.) per tie."

Signed, the Chief Engineer Maintenance of Way, Paris, July 27, 1906.

Creosote oil is distilled from coal tar. It is a heavy oil which will sink in water and which contains carbolic acid and other constituents considered effectual for the preservation of wood. Creosote oil fluctuates in price, like other commodities. At the present time the price in Europe is about four cents per gallon, while in this country it is about seven cents per gallon, depending upon point of delivery. Creosoting is far from being a cheap process, when ties or timbers are thoroughly and completely impregnated.

The several steps of the Bethell process are as follows:

(1) Steaming, one to five hours, to break cell walls and liberate the saps and juices and allow ingress of preservative.

(2) Vacuum, to withdraw vapors and induce impregnation.

(3) Introduction of creosote oil, without releasing vacuum.

(4) Pressure, not exceeding 100 lbs. from one to two hours, to refusal.

(5) Ties allowed to dry one-half hour, a vacuum sometimes applied to hasten the drying and prevent subsequent dripping.

The Rueping process, as well as the Lowry process, omits the steaming, presumably to reduce the cost of the work. This, in our opinion, is a

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great mistake. Steaming is one of the most vital factors in the treatment of ties. In the Rueping process an initial pressure of 50 lbs. per square inch is applied instead of a vacuum, so as to compress the air in the cells, and which, according to the claim of the patentees, when released, expands and forces out any desired amount of oil. Thus, instead of inducing impregnation by means of a vacuum, as in the Bethell process, it is attempted to force the liquid in by means of great pressure, running sometimes as high as 225 lbs. In the Lowry process the vacuum is also omitted, as well as the steaming, before the introduction of the oil in the retort, and a vacuum is put on at the end of the operation. Experiments have clearly demonstrated that the fluid expelled by expansion of air is not due to an initial air pressure or a final vacuum.

BURNETT PROCESS—CHLORIDE OF ZINC.

This process sometimes called "Burnettizing," after the name of the inventor, Sir William Burnett, was invented in 1838. The invention consists of destroying the tendency of certain vegetable and animal substances to decay, by submitting them to the action of chloride of zinc. The degree of dilution recommended by Burnett is one part by volume to fifty parts of water; in other words, a two per cent solution. The ties and timbers are steamed, as in the Bethell process, and the method of impregnation, under a pressure of 105 to 120 pounds, is also the same as the creosoting process. Excessive pressure is unnecessary and possibly injurious to the wood fibre. On this point we give a translation of an extract from a "Note on the Preparation of Cross Ties," published in 1898 by the French Eastern Railway:

"The ties, being thoroughly seasoned, are introduced into the impregnating cylinder, while still hot from the ovens, and the cylinder is hermetically closed. We create a vacuum and then introduce the oil into the cylinder. The creosote oil is previously heated to 80 degrees C. (176 deg. F.) and under atmospheric influences it flows into the cylinder. When the cylinder is full the oil pressure pump is put into action and oil pumped into the cylinder, and we maintain a pressure of five atmospheres (75 lbs. per sq. in.) for about one hour. Originally we carried a pressure of seven atmospheres (105 lbs. per sq. in.), but we discovered that the pressure played a secondary role, having taken precaution to obtain complete dessication (seasoning) of ties and warming them in ovens to the temperature of the oil, before placing them in the cylinder, to insure perfect fluidity of the oil. Therefore, since 1877, the pressure was reduced to five atmospheres, but maintained a little longer."

The cost of chloride of zinc is about 3½c per pound. Thus, for 100 pounds of two per cent solution, which would be equal to nearly twelve gallons, there would be two pounds of chloride of zinc, costing seven cents, which would be equivalent to seven-twelfths of one cent per gallon. If an average of five gallons of solution were injected per tie, it would cost very nearly three cents per tie. If three per cent solution were injected it would cost four and four-tenths cents per tie. The strength of the solution varies with the character of timber, and runs from about two per cent to four per cent.

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Fig. 3

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In Germany, Burnettizing meets with favor. The Stuttgart Technical Convention of 1887 expressed itself as follows:

"As the experience of those railroads that have from twenty-five to twenty-six years impregnated their sleepers (ties) with chloride of zinc, under pressure, after steaming and abstracting the saps, has been very satisfactory, and as this system costs one-third or less compared with impregnation with creosote oil or corrosive sublimate, many railroads have adopted the chloride of zinc process."

The Atchison, Topeka & Santa Fe Ry. was among the first roads in this country to treat ties on an extensive scale with chloride of zinc. That road commenced treating ties in 1885 at Las Vegas, N. M., by what is known as the Wellhouse process, which, as above stated, is a modification of the Burnett process to the extent of adding glue and tannin to the chloride of zinc solution. This treatment gave splendid results. It is said that some of the ties treated during the first three years are still in the track and the average life of ties when all removed will be about 13½ years. See diagram, Fig. 3. The glue and tannin are added to form a protective covering for soluble chloride salts.

RUTGERS PROCESS—CREOSOTE OIL AND CHLORIDE OF ZINC ADMIXTURE.

This process consists of five operations, the same as in the Bethell and Burnett processes. It was invented and introduced in 1874 by Julius Rutgers, who operates most of the treating plants in Germany. The strength of the zinc solution is the same as in the Burnett, namely, from 2 to 4 per cent, to which is added creosote oil. While the chloride of zinc is being heated, four and four-tenths pounds of creosote oil, of a certain specific gravity, is added to the solution for each 8½ foot tie, or three cubic feet of timber. The mixing of creosote oil with chloride of zinc is accomplished by means of a mechanical device and a jet of steam and air. This process is used extensively in preserving railway ties for the Prussian Railway, and to some extent in France. It is said that at the expiration of the first ten years, after the process was introduced, the Prussian Railway began to see that the results obtained from the ties treated by the combination of chloride of zinc and creosote oil were giving much better satisfaction than ties treated with chloride of zinc alone, and the new process rapidly grew in favor, so much so that at the present time nearly all of the pine and beech ties used throughout Germany are zinc creosoted. The average life of ties treated by the Rutgers process, on the Prussian Railway, is said to be about fourteen years. The French State Railway, at the International Railway Congress, in 1900, reported an average life of sixteen years for zinc creosoted beech ties. The records of that road show that ties treated by the Rutgers process lasted considerably longer than those treated by chloride of zinc alone. Perhaps one of the reasons is on account of the greater

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fluidity of chloride of zinc, penetrating deeper into the wood than is possible with creosote oil, whereby the timber gets a deeper and more thorough impregnation. Probably another reason for longer life is that the creosote oil on the exterior of the tie prevents the leaching out of the soluble salts. At any rate the French State Railway found it profitable to use a combination of the two ingredients.

The Rutgers process was introduced into this country in 1904 by the Chicago Tie Preserving Company, at Paris, Ills., located on the Cleveland, Cincinnati, Chicago & St. Louis Ry. The use of this process (when the solution is not agitated while under pressure) it is said, necessitates the importing of a special oil made by Rutgers, in order to obtain a mixture which will not separate during the time the pressure is applied to the ties, and that it has been found expensive and at times difficult to obtain. This objection can be overcome by the use of a centrifugal pump, the suction being taken from the top of the treating cylinder and the discharge entering the bottom, being distributed uniformly the entire length of the cylinder by means of a perforated pipe. The pressure on both the suction and discharge side of the pump is the same as the pressure on the treating cylinder. Therefore, very little power is required to handle large quantities of the mixture. A perfect agitation can be obtained in this manner and any good grade of oil injected into the wood, together with the zinc solution, regardless of the specific gravity of the oil. The device for keeping the solution in agitation while under pressure was invented by J. B. Card, and where it is used, the treatment is known as the "Card" process.

As it has been demonstrated beyond doubt, both in Germany and in France, that a small amount of creosote oil injected simultaneously with the injection of chloride of zinc will largely increase the life of a zinc treated tie, it is rational to believe that this method will more than pay for the increased cost of the solution.

SEASONING TIES.

Certain kinds of timber deteriorate rapidly after they are stacked in the yards for ordinary air seasoning and it has been observed, in a number of cases, that railroad cross ties become so badly decayed in the interior, after an air seasoning of six to ten months, that an ax can be easily driven into them up to the handle. The improvement in the treatment of ties lies mostly in the direction of a better method of seasoning than is now commonly practiced in this country.

By far the most important factor influencing the quality of the work is the seasoning and preparation of the ties for treatment. If this is not done properly, unsatisfactory results are sure to follow. The amount of absorption of preservative depends more upon the condition of the timber when placed in the retort, than upon its physical structure. If the wood is not well seasoned, with sap cells broken to allow the ingress

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of the preservative, it will not readily absorb the fluid, no matter how great a pressure may be applied or what the species or character of the wood may be. On the other hand, if the ties are overseasoned, which means that they are in a stage of decay through decomposition of saps and juices, they will absorb undue quantities of preservative.

STEAMING.

In order to prevent the saps and juices from decomposing and destroying the timber they should be extracted, by steaming, immediately upon arrival of the ties at the treating plant, and then stacked in the yard for air seasoning. Once the saps and juices are extracted and the wood sterilized the danger of rotting is greatly diminished and in most cases entirely prevented.

Steaming of ties furthermore shortens the time for air seasoning. It has been demonstrated that lumber, and timber generally, which was given a preliminary steaming shortly after it was converted could be seasoned in a kiln or in the open air in one-fourth of the time usually required to dry the same in an ordinary kiln or by open air seasoning, without steaming. The explanation for this is that the cell walls were broken by steaming and the saps and juices extracted and condensed steam or vapor refills the voids and when the timber was subsequently exposed to the air it dried more rapidly than timber that did not receive a preliminary steaming. In the latter the saps harden into hornlike substances, thus clogging up the pores and retarding the evaporation of the moisture in the wood.

ADZING AND BORING.

In order to realize the greatest possible benefit from the treatment of ties it is necessary to provide against mechanical mutilation of the ties after treatment has taken place. This mutilation occurs in adzing the ties to secure a firm and equally distributed bearing for the rails and in driving the common square spikes, which crush and distort the wood fibre, decreasing the resistance to flange pressure and permitting the entrance of moisture. In order to make available all of the advantages due to treatment, the ties should be adzed and bored before treatment. By this means all cutting is done before impregnation, the holes bored for the spikes, allowing the chemicals to enter the body of the tie at the points most necessary to protect it. The cost does not exceed two cents per tie, and if the average life is thereby increased only one year, it pays well to do it.

KILN DRYING AND WARMING.

When the ties have been machined and loaded on trams ready for treatment, it would be well to place them in ovens to complete the drying

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and warm the timber preparatory to impregnation, so that when the hot preservative fluid is introduced into the retort, the ties will be in prime condition to absorb it. In this way treating plants can be operated continuously, through all seasons of the year, in winter as well as in summer. It would also protect ties from drenching rains which might occur just before they are placed in the retort for treatment. In northern latitudes, during the winter, the ties and timbers are frequently covered with snow or ice, or are very cold when placed in the retorts for treatment. In such cases, when the warm preservative is introduced into the retort, it is chilled, and consequently the penetration is very slight, particularly when creosote oil is used, and the depth of the penetration is, very often, not more than ¼ inch deep. The warmer and the drier the timber is when placed in the retort, the deeper the penetration of the preservative and the better the distribution of it throughout the timber. The moisture content in timber has a very appreciable effect upon the way in which it lends itself to treatment, and any method which will place the wood in such condition that it will be in approximately the same moisture condition, is bound to result in a much more uniform penetration and absorption than can be obtained where such conditions do not exist. The uniformity with which the preservatives are distributed throughout the wood is one of the cardinal principles of proper wood preservation work.

A sufficient amount of antiseptic should be introduced, and its thorough dissemination through the piece is the essential point to be attained. The impregnation should be carried to "refusal," regardless of the kind of antiseptic that is used. **The matter of first importance** is to secure a thorough impregnation. The matter of quantity and cost of antiseptic is a secondary consideration.

Whenever the timber is treated to refusal it is not necessary to separate the woods into groups for treatment, as it seems necessary to do when ties are treated by certain processes injecting only limited quantities of creosote oil in the timber and stop the operation before the wood is completely impregnated. It is the common practice, when the quantity of creosote oil is specified, to stop the operation when the requirement is met, and before the receptivity of the charge is exhausted and the impregnation complete. This is radically wrong and shows such specifications to be faulty.

AVERAGE LIFE OF TIES.

It is our desire to give a conservative view, and as we are searching for the truth, we can hardly afford to deceive ourselves or the interested public and those specially concerned. On the other hand, it would be equally foolish to depreciate results when we have the means to arrive at what is demonstrated as probably near the truth, as near as human intellect can discern and near enough to be accepted as practically true.

What is advanced here is the summing up of observations and study of the subject during many years. It has required months of close study,

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during which a most searching analysis of recorded results has been made, with proper consideration of, and allowance for, the various collateral influences.

Unfortunately, the record of the removals and data on the life of treated and untreated ties in service are very meagre. The most complete and comprehensive record which we have been able to find is that which was kept by the Atchison, Topeka & Santa Fe Ry. and published in the late Mr. Sam'l M. Rowe's book on "Preservation of Timber," and to this, in a great measure, is due the conclusions now proposed to be given. By means of this record a close approximation is made of the percentage of treated ties removed each year. Mr. Rowe says:

"We take it for granted that measurably correct conclusions can be derived from the mean of a large number of results for the same lapse of time, and further, that causes acting as does decay of timber under similar conditions, in various periods during its history, will, if graphically recorded, form a curve."

In line with this suggestion we have drawn a dotted line on the accompanying diagram, Fig. 3, showing the mean percentage of ties removed each year, as given by Mr. Rowe. These ties, from which the record was made on the Santa Fe, were treated during the years 1885, 1886 and 1887 by the Wellhouse process, and have shown remarkable durability. We understand that a few thousand of them are still in the track at this date (1912). Therefore, some of the ties are showing a life of 25 to 26 years, and an average life of all of these ties is approximately 13½ years.

In his tabulation Mr. Rowe says that all ties removed, whether on account of decay or breaking from derailment, or of premature removal in relaying or ballasting, are included. The proportion of removals for other causes than decay is, in our opinion, very small anyway. Mechanical abrasion is almost entirely due to decay under the rail and around the spike holes. It is the decay of the wood which induces "rail cutting" and "spike killing" of ties. Prevent the decay by machining the ties before treatment, and the mechanical abrasion will be minimized.

The comprehensive and reliable record left by Mr. Rowe suggested to us the idea of drawing a diagram and showing graphically the rate at which treated ties would probably come out of the track. We observe that 58 per cent of the ties are removed when the ties have made their average life and 42 per cent are removed thereafter, and our diagram is made on this assumption. However, it matters not what percentages are assumed, the result will be the same, as the average life of ties is based on the number of tie years. The results obtained from the treatment of ties on the Santa Fe is a fair average example of what has been accomplished during the past three decades in the country.

It would be interesting to know what the curve representing the life of the untreated timber, of various kinds, really is. This has never been recorded, so far as we know, and here is the difficulty we encounter when comparing treated ties with the same untreated. The average life

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of southern pine has been variously estimated at from a mean of five years down to four years; the mean life of beech four years; red oak and black oak, seven years. It has not been the custom, in this country, to treat white oak, because it is sufficiently durable without treatment and is more expensive than other hardwoods. The average life of white oak is variously estimated from eight to ten years.

A careful record, kept by the writer, of cross ties purchased for the Lake Erie & Western R. R. during a period of 24 years, enables us to calculate closely the average life of the ties. All of the ties were white or burr oak, with the exception of about two per cent of cedar and chestnut. A careful estimate was made of the number of ties in the road which was necessary to maintain. The spacing of ties varied on different portions of the road; where traffic is heavy, they run more to the mile than on other portions of the road where lighter traffic prevails. The average number per mile on various divisions ranges between 2,640 and 3,000. Very few tie plates were used. Perhaps not more than two per cent of the entire number of ties were tie-plated. The record is as follows:

	Ties.
Approximate number of ties in track of L. E. & W. R. R. and F. W. C. & L. R. R., main and side tracks, 896 miles	2,562,500
Deduct for bridge and switch ties	200,000
Number to be maintained	2,362,500

Number of ties purchased during thirteen years, 1887to 1889 inclusive	3,324,531
Average number purchased per year	255,733
Dividing 2,362,500 by 255,733, would give an average life of 9.23 years.	
The mileage of the L. E. & W. was increased by the leasing of the Northern Ohio Ry. The mean mileage of main and side tracks, between 1900 and 1910 inclusive, was 1108 miles and the approximate number of ties	3,133,000
Deduct for bridge and switch ties	222,000
Number to be maintained	2,911,000

Number of ties purchased during eleven years, 1900-1910 inclusive	3,619,012
Average number of ties purchased per year	329,001
Dividing 2,911,000 by 329,001 ties, would give average life of 8.85 years.	

Thus, it will be observed that the average life of ties during the first period was a little longer than in the latter period. The reason for this, we presume, is because the renewals were made more liberally during the

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latter period and perhaps the ties were not of as good quality as those received during the first period. When oak ties were plentiful a better grade could be obtained than can be secured at present, the quality gradually depreciating. Again, during the past ten years, possibly a good many red oak ties were accepted as white oak ties, and it is quite well known that the average life of red oak ties is at least two years less than that of white oak ties. Taking the two periods together, we estimated the average life of white oak ties to be **nine years.** We have known some white oak ties to last as long as sixteen years. Of course, they were very few; perhaps two or three in every hundred. It must also be borne in mind that a good many ties go in side-tracks, where they are made to last longer than the general average, because it is not as imperative to renew them as often as is the case with main-track ties.

It is currently reported that in France and England creosoted ties have been known to last thirty years. This is true, but it must be borne in mind that this is not the mean or average life; in fact, we are reliably informed that only two or three ties in one hundred last that long. The average life of oak or beech ties, treated in France and England, with creosote oil, to refusal, adzed and bored and warmed in ovens, prior to impregnation, as near as we can judge from available data, is about fifteen years. The mean or average life is that which represents the sum of the life of all, divided by the number, and this method is evidently the only practical measure.

The best practical illustration of the progress of decay will be the facts as they occur. The year in which the ties are put in the track is the starting point. The year in which the first ties fail is another step, and the rate from then on is the curve of failure; and the year in which the last ties are removed is the culmination. If every piece were exactly alike in texture, density or soundness, all should fail at once, but this is never so.

The curves, in diagram, Fig. 3, illustrate graphically how treated ties would be removed from the track when their average life is from eight to sixteen years. The tables show the percentages and tie years for each curve. These curves of failure and tables of percentages can be used to determine closely the length of service railroad companies are getting out of the treated ties now in the tracks. By comparing the removal with the number of ties treated in any one year, it will show which "curve of failure" it is following and give the mean life of ties, which is the essential thing to know.

COST OF TREATED TIES IN TRACK.

The quality and kind of antiseptic and method or process of application determine to a very large extent the life of the tie. Of the various antiseptics, there are practically only two in common use in this country, namely, chloride of zinc and creosote oil, used either singly or in com-

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bination. Crude oil is used in limited quantities and the results seem to be promising. Of the methods or processes of application there are many, some quite successful, while others are failures. Without going into the merits or demerits of the antiseptics or processes at this time, we have attempted to combine in a table the average life of ties treated with different kinds of antiseptics by different methods or processes of treatment. We believe that the table will be found a close approximation, when careful and due consideration is given to the several features which enter into the problem.

The cost of untreated wooden ties varies greatly in different sections of the United States, as well as the various species of woods, varying from 30 cents to 75 cents for 6 x 8 in. x 8 ft. ties. The cost of preservative treatment also varies according to the processes of chemicals employed and the thoroughness of the work. It ranges from 12 to 42 cents per tie. The useful life of treated ties has not yet been fully determined. However, we can arrive at a close approximation from the data now available, both in this country and in Europe. The relative economy of different kinds of ties treated in various ways is a question that most keenly interests the railroad managers. As between ties equal in their safety and utility the elements that enter into the problem of relative economy are:

(1) Cost of the ties delivered (including cost of treatment when treated).

(2) The useful life of the tie (average or mean life).

(3) The cost of renewals and of track maintenance, in so far as it may be affected by the kind of tie used.

(4) The cost of interest on investment of a sinking fund.

The cost of putting a new tie in the track and taking it out, when worn out, may properly be considered a part of the cost of track maintenance and charged to the cost of the tie. It is estimated that it costs about 12 cents to take an old tie out and put a new one in. We should add to this three cents for distribution, and if we charge 15 cents against the new tie for renewals we would not be far out of the way. If we take into consideration the disturbing of the ballast and roadbed every time a tie is removed, we would have to add two or three cents more per tie to cover the cost of wasted ballast and surfacing the track.

Referring to the accompanying table, Fig. 4, giving "Annual payment into a sinking fund, which at 4 per cent of interest, for five to twenty years, will amount to fifty cents to one dollar and thirty cents," this table can be used to determine:

(1) The price which white oak, yellow pine, cedar and chestnut, lasting five or more years, must reach before it will be economical to use treated ties.

(2) How long ties of different species of wood must last in order to be as economical as white oak, yellow pine, cedar and chestnut ties, at various prices, lasting five years or more.

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Fig. 4

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(3) The price that can be paid for different kinds of treated ties in order to be as economical as white oak, yellow pine, cedar or chestnut ties, which do not require treatment, and last five years or more.

(4) How much more can be expended for steaming, machining and oven drying cross ties, prior to impregnation, to secure a longer life, if deemed advisable.

(5) What economy can be effected by using tie plates to lengthen the life of the ties.

(6) Given the cost of a tie, including treatment, laid in track, with or without tie plates, and the average life, it is possible to ascertain readily the annual charge of any combination.

In estimating the relative cost or economy of different ties it is common to divide the first cost of the tie by the number of years' service which it may be expected to give, and call the quotient the annual cost of the tie. This is not correct and may lead to erroneous conclusions. The interest charge should be taken into account. The annual cost should be computed by the formula shown on the accompanying chart and table. The formula is that used for calculating annuities and may be found in common school arithmetics.

In order to compare the relative economy of treated ties, treated in different ways, we have assumed the cost of the tie to be 45 cents, fuel ¾ cent, supplies ¼ cents, repairs and depreciation 1½ cents, superintendence ¼ cent, and laying in track 15 cents per tie for all combinations.

We believe this represents a fair average price among treating plants in this country. Granting that we have correctly estimated the cost of the tie, laid in the track, and the average life of the same, as given in the table, the annual charge would be from 7.11 cents for the lowest combination (G-L) to 10.88 cents for the highest combination (E-M). The difference between the highest and the lowest is 3.77 cents per tie year. If we take the mean life of the two, which would be 15½ years, and multiply it by this difference per tie year, it would make 58 cents per tie, which represents the relative economy of the two combinations.

Combination G-L is chloride of zinc and creosote oil mixed, injected to refusal, with ties steamed immediately upon arrival at the plant, air-dried an average of three months, machined and then warmed in ovens just prior to impregnation. Cost of treated tie laid in track, 79 cents; average life 15 years; annual charge 7.11 cents. Combination E-M is the same with the addition of tie plates. Cost of treated tie laid in track, $1.26½; average life, 16 years; annual charge, 10.88 cents.

W. F. GOLTRA.

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CHART AND TABLES

In forming the tables, Fig. 3, showing the relative economy of ties treated with various antiseptics and by different methods, the author has endeavored to put himself in that frame of mind which was most natural and most reasonable to secure him from error, so far as possible. He set out with perfect distrust of his own ability; a total renunciation of every speculation of his own; and with the earnest desire to get at the facts as they seem to be authenticated, and to weigh them and to give each their due consideration and allowance. Starting with the assumption that ties treated with a limited quantity of creosote oil, say, an average of two and one-half gallons per tie, seasoned in ordinary manner, would have an average life of ten years, we estimate that the life would be increased two years if they were treated to refusal with creosote oil (two to seven gallons per tie, or an average of four and one-half gallons per tie). And it is assumed that the average life of all kinds of ties treated to refusal with a mixture of zinc chloride and creosote would last just as long as those treated to refusal with creosote oil only, namely, twelve years. On account of possible leaching out of zinc chloride, it is estimated that the average life would be one year less, or eleven years, when treated with zinc chloride alone. Upon these assumed averages it is estimated that the life of each of these four different combinations would be increased one year, by adzing and boring of the ties before impregnation; another year if the ties were steamed in the retort immediately before impregnation, so as to obtain a deeper penetration; another year if the ties were warmed and dried in ovens prior to impregnation, so as to obtain a still deeper penetration and dissemination of the fluid, and, finally, another year if the ties are laid with tie plates.

Some may argue that these estimates are all based on guesses. That is partly true. We have made due allowance for the various factors entering into the problem of timber treating, to the best of our ability. We may have overestimated the value of some of the factors in some cases, or underestimated in others, but any one who does not agree with our "guesses" is privileged to guess for himself, but we would like for him to reduce his guesses to some measurable basis, as we have done. The fiercely asserted rival claims, made by advocates of various methods of timber treating, renders it imperative to adopt a means of reducing arguments to some measurable basis that will be equally fair to all, and afford railway officials and advisory boards, who determine the policy for their respective roads, justification for selecting a method for treating railroad ties that will combine efficiency with economy.

APPLICATION OF TABLES.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

As previously stated, The Atchison, Topeka & Santa Fe was the first railroad to adopt the Rueping Creosoting Process, and Mr. Faulkner tells

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us that it was adopted by his people during his administration, because they were not satisfied with the Zinc Chloride treatment. At the time the Rueping process was adopted by that road, it was unknown and untried. Not a single road in this country or any other country had ever used it. The Santa Fe had no experience with this process other than laboratory comparative tests. The road was getting an average life of 13½ years from ties treated with zinc chloride, as shown on Chart, Figure 3, and the cost for treating, which included chemicals, labor, fuel, and supplies, was a little less than 14c per tie, as reported in Mr. Sam'l M. Rowe's book on Timber Preservation, page 177. It is estimated that pine ties treated with only an average of two gallons of oil per tie will give a mean life of ten years, and Mr. Faulkner says that the cost of treatment is about 20c per tie. Let us compare the two and see which is the more economical method.

ZINC CHLORIDE PROCESS.

Used from 1885 to 1906, inclusive.

Cost of tie, estimated	$ .45
Cost of treatment	.14
Laying in track and distribution	.15
Total	$ .74

Average life of tie 13½ years, Annual charge, from table, .0721.

RUEPING PROCESS—CREOSOTE OIL.

Used from 1906 to date, Sommerville, Tex., Plant.

Cost of tie, estimated	$ .45
Cost of treatment	.20
Laying in track and ditribution	.15
Total	$ .80

Estimated average life 10 years, Annual charge, from table, .0984.

The difference between the two methods amounts to .0263 per tie per year. Multiplying this factor by the mean number of years, which in this case is 11¾ years, we get .319 or nearly 32c per tie, and this represents the relative economy in cost between ties treated by zinc chloride and the Rueping Process. We understand that 1,200,000 ties are treated annually at the Sommerville plant. Therefore the increased cost imposed on the Santa Fe, by the adoption of the Rueping Process, amounts to $384,000 per year, which is considerably more than the entire cost of the plant.

CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RAILWAY COMPANY.

The Cleveland, Cincinnati, Chicago & St. Louis Railway Company was the first railroad to adopt the Lowry Creosoting Process. The author

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was General Tie Agent for that line from November 1st, 1907, to November 1st, 1910, and had a good opportunity to observe the workings of the process and cost of treating the ties. The ties are furnished by the railroad company, delivered on the yard at Shirley, Indiana. These are treated by the American Creosoting Company, on a contract for a term of ten years, the treating company furnishing the oil, but the railroad company transports it free over its own lines.

PRESENT COST OF TREATED TIES LAID IN TRACK
TREATED AT SHIRLEY, INDIANA.

6 x 8″—8′ and 7 x 8″—8½′ Ties.

Cost of tie, including haul to plant (average)	$ .55
Cost of treatment, by contract	.30
Cost of handling at plant, including switching	.02
Interest on capital locked up in stock of ties on hand, in excess of quantity which is necessary to carry under improved method	.02
Free transportation of oil, fuel and supplies on the C. C. C. & St. L. Ry	.02
Ditributing and laying track	.15
Total cost of tie laid in track	$1.06

We estimate the average life of ties treated by the Lowry Process, as now practiced at Shirley, Ind., at ten (10) years.

Comparing this with the improved method, fully explained in Part 2:

TIES HANDLED, PREPARED AND TREATED BY THE
GOLTRA PROCESS.

COMBINATION G-L.

Cost of tie, including haul to treating plant (avg.)	$ .55
Cost of treatment complete, including machining, oven drying and labor of all kinds	.19
Distributing and laying track	.15
Total cost of tie laid in track	$ .89

We estimate the average life of ties treated by the improved method at fifteen (15) years.

Comparing the annual charge of the two methods, from the table, Figure 4, we have:

A tie that costs $1.06 laid in track and lasting ten (10) years, annual charge	$ .1304
A tie that costs $0.89 laid in track and lasting fifteen (15) years, annual charge	.0801
Difference per tie per year	$ .0503

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Multiplying this by the mean number of years, which in this case is twelve and one-half (12½) years, gives $0.6287. In other words, the ultimate cost of each tie treated by the Lowry Process is between sixty-two and sixty-three cents more than by the latter process. The total number of ties treated annually at Shirley, Ind., is in the neighborhood of 750,000. Therefore, the difference amounts to $471,525.00 annually. This seems almost incredible, but it is positively true.

In the above calculations we have not taken into consideration the interest on the investment, which would be required for a new plant which would cost completely equipped, exclusive of land, about $150,000.-00, which at 6 per cent would amount to $9,000.00. Nor have we included patent royalties of one cent per tie, $7,500.00 per year. Other expenses, $3,500.00 per year, brings the total to $20,000.00. Therefore, a net gain of $451,525.00, or in round figures $450,000.00, could be effected annually by adopting correct methods of handling, preparing and treating ties for the Cleveland, Cincinnati, Chicago & St. Louis Railway.

THE LAKE SHORE & MICHIGAN SOUTHERN RAILROAD COMPANY and THE MICHIGAN CENTRAL RAILROAD CO.

The Lake Shore & Michigan Southern Railway Company made a contract with the American Creosoting Company in May, 1909, by which a minimum of 1,200,000 ties shall be treated annually for a period of ten years, from January 1st, 1910. The plant was built at Toledo, Ohio, and put in operation in the spring of 1910. The railroad built and furnished all the tracks and platforms at an expense of upwards of $110,000.-00. Treated ties from this plant are supplied to the Michigan Central Railroad, Toledo & Ohio Central Railroad, and other New York Central Lines.

PRESENT COST OF TREATED TIES LAID IN TRACK. TREATED AT TOLEDO, OHIO.

Cost of tie including haul to treating plant, average	$ .60
Cost of treatment	.30
Cost of handling at plant, including switching	.02
Interest on capital locked up in stock on hand, in excess of quantity which is necessary to carry under improved method	.02
Free transportation of oil, fuel and supplies over L. S. & M. S. Ry	.02
Distributing and laying in track	.15
Total cost laid in track	$1.11

We estimate the average life of ties treated by the Lowry Process, as now practiced at Toledo, Ohio, to be ten (10) years.

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Comparing this with improved method, described in Part 2:

TIES HANDLED, PREPARED AND TREATED BY THE GOLTRA PROCESS.

COMBINATION G-L.

Cost of tie including haul to treating plant, average	$ .60
Cost of treatment, complete, including steaming, oven drying, machining and labor, all kinds	.19
Distributing and laying in track	.15
Total cost laid in track	$ .94

We estimate the average life of ties treated by the improved method to be fifteen (15) years.

From table of annual charge, Figure .., we have:

A tie costing $1.11 laid in track and lasting ten (10) years, Annual charge	$ .1365
A tie costing $0.94 laid in track and lasting fifteen (15) years, Annual charge	.0846
Difference per tie per year	$ .0519

Multiplying the mean number of years, which in this case is 12½ years, by 0.0519 gives us $0.6487. In other words the ultimate cost of ties treated by the former method is between 64 and 65 cents more than by the latter method. On 1,200,000 ties treated yearly the difference amounts to the enormous sum of $778,440.00. In the above calculations we have not taken into account the interest on the investment which would be required for a new plant, capable of treating 1,200,000 ties per annum. Such a plant would cost complete, including all tracks and equipment, but exclusive of land, $150,000.00, which at 6 per cent annually would amount to $9,000.00. Patent royalties, one cent per tie, $12,000.00 and other expenses $6,000.00 or a total of $27,000.00. Deducting this amount from the above leaves $751,440.00 or in round figures $750,000.00 that could be gained annually by adopting correct methods of handling, preparing and treating ties for the Lake Shore & Michigan Southern and other New York Central Lines, supplied with treated ties from the Toledo, Ohio, plant.

Similar results will be obtained when the tables of measurement are applied to other lines, using the so-called "empty cell" processes. We estimate that approximately 15,000,000 ties are treated annually by the Lowry and Rueping patented creosoting processes. An average gain of 50c per tie, or $7,500,000 annually could be effected by employing correct methods for seasoning, preparing and treating these ties, so as to give them the longest life at the lowest cost.

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PART II

Improved Method of Treating Ties and Timbers

Goltra Process

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Fig. 5

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Figs. 6, 7, 8

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IMPROVED METHOD OF TREATING TIES AND TIMBERS.

The science of timber preservation, by treatment with chemicals, is one of the liveliest subjects before the American people today. Many problems in the art of treating wood with antiseptics have yet to be solved and there is undoubtedly much room for improvement. From years of experience, coupled with careful study of this subject, we conclude that much improvement over methods commonly employed in this country lies in the direction of a speedier and more efficient method of seasoning, a better preparation for impregnating of ties and timbers, as well as greater economy in handling of the material. Despite the diversity of practice it is possible to find, among the experienced and practical operators, both in this country and abroad, a measure of agreement as to both methods and results and from these to outline the essentials of a correct method. Sufficient data is obtainable to form a correct opinion as to the best preservative agents and method of treatment that should be employed to produce the best and most economical results.

It is our desire to submit for consideration, to those interested in timber preservation, a new and original method of treating ties and timbers with preservatives. Several distinct steps are taken in carrying out this new method or process, consisting of:

a. Steaming of ties upon delivery at plant.
b. Stacking of ties in the yard for open air seasoning.
c. Machining of ties preparatory to impregnation.
d. Completion of drying and warming ties in ovens.
e. Impregnation with antiseptic liquid.

In carrying out this method or process, a suitable plant is required and the accompanying drawings, Figs. 5, 6, 7, 8, illustrate such a plant with all the necessary appointments and equipments for making the process effective, such as steaming cylinders, drying yards, ovens for further drying of ties and timbers and cylinders for impregnating with antiseptics.

Considering now the several steps we have

(a) STEAMING OF TIES.

Immediately upon arrival of the ties or timbers at the treating plants, they are transferred by hand from standard gauge cars to narrow gauge tram cars, which are placed alongside of the standard gauge cars. The tram cars being loaded, are run on tracks in the steaming cylinder. The cylinders are provided with a heavy cast steel door, adapted to slide up and down and close hermetically. It is operated by an electric hoist

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and can be lowered or raised in the space of one minute. The ties or timbers, in whatever form, are then subjected to live steam for a period varying from thirty (30) minutes to four (4) hours, depending upon the character and condition, such as thickness of pieces, density of the wood, proportion of heart wood and sap wood, species of wood, moisture condition and the like, and at steam pressure of about fifteen (15) pounds per square inch. In most cases possibly fifteen (15) to twenty (20) pounds should be the maximum, for reasons hereinafter set forth.

Now in order that this step in the process may be clearly apprehended, both as to its own importance and its preparatory value for whatever is to follow, it will be observed that steaming the wood as above indicated has the effect

(1) Of breaking the cell walls and producing narrow microscopical slits, through which the juices and saps in the cells and intercellular spaces are liberated. Slow steaming gradually heats the wood through and through to the center of the piece, expanding the moisture of the cell into vapor, causing the juices in the wood to be rapidly expelled. Live and growing timber with its natural saps and its sap cells in their normal condition, will resist the introduction of any fluid, much on the same principle that two bodies cannot occupy the same space at the same time. To be able to introduce any solution, under these conditions, the natural sap in the timber must, in some way, be first freed and expelled from the timber, either by being evaporated by drying, or forced out by steam.

(2) Steaming effects a great reduction of the time subsequently required for seasoning the wood, whether it be in a dry kiln with heated air, or by natural air seasoning. It has been demonstrated that steaming lumber in a suitable chamber before entering the kiln will materially reduce the time for drying. Railroad ties, piling and similar heavy timbers will dry as much in two or three months after getting a preliminary steaming, as they would in nine months to twelve months, by natural air seasoning without steaming. This greatly reduces the stock necessary to maintain on hand and thus reduces about three-quarters of the capital that might otherwise be locked up in stock on hand, when the ties or timbers are not steamed. It further effects a material economy in the cost of installation of a treating plant, by proportionately diminishing the storage yard space and length of tracks needed to handle the ties. Fire insurance and taxes are also correspondingly reduced.

The reason why cross ties and lumber dry so much more rapidly, when subjected to the steaming pressure, is because the saps and juices in the cells have been extracted and the voids filled with vapor, which evaporate far more rapidly than the saps, when the material is subsequently exposed to the air for drying, and because the cell walls are broken and the wood liberates the vapor or condensed water very readily.

(3) Steaming dissolves and withdraws the juices and saps contained in the wood and prevents decay when subsequently dried. When

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green ties, and lumber generally, are piled for air drying without preliminary steaming, the saps and juices ferment and decompose rapidly and the decay attacks the delicate cells and less compact portions of the timber and then the firmer portions until, in a few months, the timber becomes spongy or doaty in the interior and its strength impaired and in this condition it absorbs undue quantities of preservatives, when afterwards treated. Timber that has reached this stage, which is usually called "over-seasoned," will absorb the preservative freely, but the excessive absorption is valueless and wasted. On the other hand steaming arrests incipient decay and destroys such fungi as may be contained in the wood. Its action abstracts and withdraws the foods (saps, juices and organic matter) upon which the germs of decay, which may be inherent in the wood, are supposed to subsist while the timber is air seasoning.

(4) Steaming softens the outer surfaces and opens the pores of such timbers as may have had a preliminary air seasoning and which may have become "case-hardened," thus permitting rapid evaporation of the moisture contained in the interior of the timber and thereby preventing much of the checking and splitting, which is so common in cross ties and timbers generally, while undergoing air seasoning. Whenever ties and timbers dry rapidly, in the open air, without sufficient surrounding moisture, many of the hardwoods "case-harden," that is, the outer part shrinks before the interior has had a chance to do the same and thus forms a hard shell or case of shrunken wood around the interior. This shell does not prevent the interior from drying, but when this drying occurs the interior is commonly checked along the medullary or pith rays. In practice this occurrence can be prevented by steaming the lumber and then drying it, either in a kiln or in open air. Most of the checking and splitting of railroad ties while seasoning naturally in the open air is due to the inequality in drying. It has been observed that the ends of ties that are more or less exposed to the elements, checks and splits much more than other portions of the stick. This is mostly because the shrinkage, which always occurs when wood is drying, is not uniform throughout the piece. By giving the wood a preliminary steaming, which opens the pores and cells of the wood throughout, the drying will be more uniform, as well as more rapid. Consequently these defects are minimized and in most cases prevented and the wood comes together more compactly and firmly than in ordinary air seasoning alone.

(5) The chief point in securing good treatment is to withdraw the juices, saps and acids from the timber. Hence steaming is an essential part in the process of treatment of wood, not only as to the effect on the timber, extracting the juices and toughening the fibre of the wood, but in a general way to prepare it to absorb the chemical preservative, whatever it may be. The slitting of the cell walls caused by steaming renders the wood more permeable and the slits do not reunite when the timber is submerged in the preservative. Professor Harry D. Tiemann, of Yale Forest School, United States Forest Service, made a very careful and

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original examination of the physical structure of wood in relation to its penetrability by preservative fluids and the results of his findings are summarized by him in a report printed in the American Railway Engineering Association's proceedings of March, 1910, as follows:

To emphasize the main principles established by his research the results will be stated in the following concise form:

(1) All wood in the fresh green state are impenetrable to gases, even under high pressure, except through the open vessels in the angiosperms and the resin ducts in the conifers, where these are not clogged by tyloses or resin. The same is true as regards liquids, except that water solution may gradually seep through the membranes. Since it is the wood fibres and the tracheids which form the main part of the structure of the wood, impregnation of these vessels or ducts would be of little use of itself in preservative treatment. The above is due to the fact that every cell is a closed vessel, completely surrounded by its primary wall.

(2) Whenever wood seasons (beyond the fibre saturation point) whether naturally or by artificial means, narrow microscopical slits occur in the walls of the fibres and tracheids which render them permeable to gases and liquids. These slits do not reunite when the wood is resoaked, although they may close up somewhat. The greater the degree of dryness the more permeable the wood becomes.

(3) Steaming green wood produces a somewhat similar effect, but to a less degree, unless the wood is subsequently dried also. The reason then that absolutely green wood cannot be successfully treated with preservatives is due, not so much to the fact that the wood contains water, but because the cell walls are unbroken and therefore impenetrable. Just what pressure these walls would resist it is impossible to state, but it seems probable that it would run into the thousands of pounds per square inch.

In connection with this statement, it should be distinctly noted that by the immersion of green wood in hot oil the heat of itself may produce more or less seasoning and steaming, particularly if the oil is heated to 212 deg. F. which would, therefore, have itself the tendency to open these slits in the walls also. Thus some penetration might be obtained with green wood in hot oil.

Among the species experimented upon were long leaf pine, white pine, loblolly pine, red spruce, white oak, red oak, black oak, chestnut and tulip. Air and steam pressure up to 130 to 150 pounds per square inch were used in some cases. In not a single case was an exception found to the statements made in this article.

According to Professor Tiemann, air seasoning or steaming is necessary to open the slits in the walls of the cells of the woods which are otherwise impenetrable to fluids under pressure, and that the slits or openings, which permit entrance of the fluids to the cells, begin when the moisture in the cell walls begins to dry out. He further observes that steaming green wood produces a similar effect as air seasoning, when wood is subsequently dried; and that the greater the degree of dryness the more permeable the wood becomes.

(6) Experiments under varying conditions indicate that large timbers, such as railroad ties, piling, etc., may be steamed at twenty pounds pressure for as much as four hours without material depreciation of strength. It is well known that if any wood is subjected to excessive

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steam pressure for a considerable length of time the wood fibre is disintegrated or pulped, and even under less pressure the strength of the wood is impaired. Even less time and pressure will release the coloring matter contained in the wood and render it pale, colorless and deficient of character, but it has been demonstrated that wood subjected to live steam under pressure not exceeding twenty pounds for a time varying from thirty minutes to four hours, according to kind and thickness of wood, the coloring of the wood is distributed, equalized and rendered approximately uniform; the strength of the wood is unimpaired and its milling and finishing qualities materially enhanced.

The duration of the steaming is determined by the color of the condensation from the cylinders. At first the condensed water runs off fairly clear and colorless, but later on it gets much darker and discolored and has a peculiar woody smell from the extracts dissolved. Steaming is continued until this stage is passed and the condensed water again runs clear and colorless, showing that the sap has been dissolved and withdrawn to the fullest extent possible.

The moisture in timber amounts to from sixteen to sixty-five per cent. It is unequally distributed in green timber, being greatest in the sap wood. The per cent of moisture present in different kinds of wood is approximately as shown in the accompanying table:

	Sap wood or outer part	Heart wood or interior.
Pine, Cedar, Spruce, Firs	45—65	16—25
Cypress, extremely variable	50—65	18—60
Oak, Beech, Ash, Maple, Elm, Hickory, Chestnut, Walnut and Sycamore	40—50	30—40

The lighter kinds of woods have the most water in the sap wood, thus sycamore has more than hickory.

It is manifest that the greater part of this moisture must be removed in order to put the timber in condition to receive treatment with antiseptics. While it is true that by long continued exposure to open air timber can be sufficiently dried to meet common requirements, it is evident that such methods require too much time and space to meet modern conditions. What is more, ties and timbers air season without preliminary steaming, are not in reality dry, even after many months of exposure, and their remaining moisture is unevenly distributed to insure good behavior during impregnation. But, by steaming the ties or timbers immediately upon arrival at the plant and extracting the saps and then stacking in the yard for air seasoning, much more satisfactory results will be obtained.

When steaming sawed ties, or lumber, the pieces should be piled on cross sticks, about one inch apart horizontally, so that the steam will have access to all surfaces. The steam pressure should be only a few pounds at the beginning and gradually increased to not exceeding twenty pounds at the end of the operation, so as not to heat the timber too

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suddenly, which might cause checking and splitting, an effect which frequently occurs when hot oil is introduced in the retort on cold ties.

Experience has demonstrated that it is not feasible to impregnate timbers with antiseptics immediately following the steaming, because the cells are filled with vapor and condensed steam, which resist the entrance of the chemical. A fair penetration can be obtained with zinc chloride, but scarcely any at all with creosote oil. It is very essential that the ties and timbers be dried after the steaming.

(b) STACKING OF TIES IN YARD FOR AIR SEASONING.

Having taken the initial step in the seasoning process by steaming, the next in order is to evaporate the condensed steam or moisture from the ties or timbers. This is accomplished by stacking in a yard for air seasoning.

The loaded tram cars are drawn out of the steaming cylinders by a small locomotive or any suitable means and placed on a transfer table. The table, operated by power, is moved to one of the parallel yard tracks and the tram cars are drawn to the place where the ties are to be stacked. The time required to transfer the loaded trams from the steaming cylinders to any point in the yard is about five minutes, and the transfer table greatly facilitates the handling of ties in the yard. The tracks in the yard are laid double, three rail, so that a standard gauge locomotive crane can stand on one track and unload narrow gauge tram cars standing on another. The use of the locomotive crane and transfer table effects great economy in the time and labor. The cost of labor for handling ties, from the moment they are unloaded from the standard gauge cars, steamed and finally stacked in yard, is less than when the ties are stacked directly from the standard gauge cars, without locomotive crane and transfer table. Furthermore the use of a locomotive crane and transfer table materially reduces the cost of building a plant, as the arrangement of the yard, thereby made possible, affords a better utilization of the space for stacking ties, lessening the space required and correspondingly lessening the lengths of tracks; also obviates the expense for the construction of a high loading platform, as the treated ties are transferred directly from tram cars to standard gauge gondola cars, from yard level, for shipment to destination. The space required for a plant having the capacity for treating upwards of one million ties annually is about twenty acres, and the length of the tracks in the yard is approximately four miles. The ties should be piled in such manner that the air will have free access to all surfaces, and a good way to stack ties for seasoning is to pile them by what is known as one by eight and running the stacks fourteen to sixteen feet high, which can easily be done with a locomotive crane.

As previously stated, ties which have been given a preliminary steaming dry rapidly, and the average time required to evaporate the moisture from them to put them in condition for treatment is about three months, depending upon the character of the wood and climatic conditions. Ordinarily it requires from nine months to twelve months in the open air for hardwood ties to season sufficiently for treatment.

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(c) MACHINING TIES.

When the ties have sufficiently seasoned and are ready for treatment, they are taken from stacks, passed through an adzing and boring machine and loaded directly on tram cars to be transported to the ovens for the completion of the drying and thence to the impregnating cylinder for treatment with preservatives.

The adzing and boring machine is preferably mounted on a standard gauge box car, which is moved about the yard and placed opposite the stacks of ties. A skid is placed between the stacks and the car on one side, and another skid is placed between the machine car and tram cars on the other side. In loading ties on tram cars care should be exercised to pile them loosely, both vertically and horizontally, to permit the heated air in the ovens, as well as the preservative fluid in the retorts, to come in contact with all surfaces. If the ties are sawed the parting strips should be about one inch thick to keep the surfaces apart. It is not absolutely necessary to use parting strips for hewed ties. The yard tracks are so arranged (being double, three rail) that the machine car can be placed on one track and the tram cars on the other, which enables the machining of ties to be performed in the most economical manner.

There are two causes of tie deterioration, decay and mechanical wear, and there is no economy in increasing the resistance of one without also increasing the resistance of the other. Of these two destructive agencies decay is much the greater, but it is so interwoven with mechanical wear that the two should be considered together. Heavy rails and the use of tie plates are only partial preventives of mechanical abrasion and do not reach the chief causes of mechanical destruction. Under existing conditions, the greatest possible life and efficiency of ties is not obtained by American railroads and to a large extent this failure is due to two causes: (1) on account of ties not being properly seasoned for treatment with antiseptic, and (2) on account of not being properly prepared for service in track. I have already given attention to the first cause and will now consider the second.

It has been almost the universal practice on English, French and several European railways, to machine their ties before attaching the rails or rail chairs to them. The consensus of opinion in Europe is to the effect that such preparation, by machining, is of marked economy. Years of observations and tests, on both treated and untreated ties, have proven that longer life is obtained by the machining operation. The majority of ties, either hewn or sawn, are somewhat winding when placed in the track, and hewn ties may offer a very irregular surface for one or both rails. This causes a tie to work in the ballast, diminishes its load bearing capacity and increases cost of track maintenance. The tie seats for both rails should be in the same plane. Indeed few even of the sawn ties present bearing surfaces to the rail that are in the same plane. Most ties, whether sawn or hewn, are either bowed or winding, and in either case the rail crushes down the wood at the high contact

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point. The machining of ties obviates the necessity of adzing them before laying in the track, thereby effecting a saving in the time and labor of the section men. It should also be borne in mind that during the time that ties are air seasoning, some distortion in shape will occur, and if adzed mechanically will have faces on the same plane.

In fastening a rail to a tie, either a cut spike must be driven, or a screw spike must be turned into the tie structure. If a screw spike be used in any form now on the market, it is absolutely necessary to first bore a hole for it to enter. If a cut spike be used it is possible to drive it in most of our American tie woods without previously boring a hole, but even though it is possible to drive a spike without boring first, it has never yet been proven advisable to do so. Skilled wood workers and mill-wrights know that the holding of a heavy spike is greater when it follows a small hole than when driven directly into the wood structure. They also know that each spike can be relied upon for an average holding power when it is driven to follow a hole, because it will not open cracks nor lead off into checks nor dodge the knots. It has been demonstrated that a spike driven into a bored hole has also much greater resistance to lateral pressure because it has the backing of the more solid wood, instead of broken and distorted fibres. Tests of 9/16″ square spikes driven into 7/16″ round holes, show much more uniform as well as greater holding power than 9/16″ spike directly driven. With the usual method of driving a cut spike into the tie there is excessive mutilation of the wood fibre, along the body of the spike, and a mass of crushed fibre forced forward at the point of the spike. In many cases it actually splits out in large sections in the lower half of the tie and in many more cases it causes serious checks. Furthermore, the boring of ties to be treated is very essential because the holes become mediums through which chemicals reach the interior of the ties and penetrates radially from each hole, thus promoting impregnation. In consequence also, the spike never opens the grain of the wood beyond the penetration depth.

Thus, a tie when first properly seasoned, then adzed and bored and then properly treated with antiseptics, has received the most perfect protection at every point against the destructive agencies of decay and mechanical wear.

It is essential to know the date when the ties were treated. Some railroads affix galvanized dating nails. This method is expensive and unsatisfactory. Instead of using dating nails a pneumatic branding device, consisting of two opposite cylinders with pistons, provided with dies for stamping dates, or any other information, and controlled by automatic air valves, may be placed directly behind the boring spindles and so timed to the machine feed that when the tie moves to the proper position, the dies advance and leave their deep sunken impression in both ends of the tie.

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(d) COMPLETION OF DRYING AND WARMING OF THE TIES IN OVENS.

After the ties have been machined and loaded directly upon tram cars, they are transported to the drying ovens and from thence to the impregnating retort hereinafter described.

The moisture content in timber has a very appreciable effect upon the way in which it lends itself to treatment, and any method that will place the wood in such good condition that it will be approximately the same moisture condition throughout is bound to result in a much more uniform penetration and dissemination of the antiseptic than can be obtained where such favorable conditions do not exist. The uniformity with which the preservative is distributed through the wood is one of the cardinal principles of proper wood preservation work. Slow air seasoning is not found sufficient to insure a good preparation of the ties and timbers for treatment and the drying should therefore be completed in the ovens. In France some of the treating plants are equipped with drying ovens and the seasoning of ties is completed just prior to the treatment with antiseptic. In this way, it is claimed that a much better penetration and a more uniform distribution of the antiseptic is obtained, than when this process is omitted.

Different woods absorb heat with different degrees of rapidity, depending principally upon the conductivity of their fibres. It has been demonstrated that an average of twenty-four hours is sufficient time to heat timbers, such as railroad ties, through and through, and during this time the moisture content will be reduced three to four per cent. Of course, the timber will lose a much greater percentage of moisture during the air seasoning period, depending upon the length of time it is exposed to the open air and climatic conditions, but the object in placing it in ovens is not only to complete the air drying, but for two other very important reasons, namely, (1) it permits a perfect regularity of operations at the plant in all seasons of the year and in all kinds of weather, and (2) the timber thus dried comes to the impregnating retort in a hot condition and the high temperature of the impregnating fluid, when introduced into the retort, is maintained when it comes in contact with the wood, consequently the penetration is deeper and more perfect. During the winter season, especially in the northern latitudes, it is frequently necessary to close down the works on account of ties being covered with ice and snow. When such ties are placed in the retort for treatment the warm impregnating fluid is chilled and congealed and, in consequence, the penetration is very slight. Again, ties exposed to the weather immediately prior to treatment are often drenched by heavy rains and absorb considerable water. This offsets, in a great measure, the air seasoning and makes it quite impossible to obtain good results from such seasoning alone. But with the ovens it is possible to get prime conditions preparatory to antiseptic treatment, and also hurry the seasoning of any timber which might be urgently needed.

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In drying wood in the ovens, whether in the form of railroad ties, standard stock, or finished products, the application of the requisite heat and circulation must be carefully regulated throughout the entire process, or warping and checking are certain to result. Again, wood of different shapes and thickness is very differently affected by the same treatment. Finally the tissues composing the wood, differing in form and physical properties as they do, and crossing each other in various directions, exert their own peculiar influence upon the behavior of the wood during the drying. For instance, with our native woods, summer-wood and spring-wood show distinct tendencies in drying, and the same is true, in a less degree, of heart wood and sap wood. Or again, pronounced medullary rays further complicate the drying problem. Thus some woods yield their moisture more readily than others, so that the time for drying differs widely with the species as well as with the intended use. The rapidity with which the drying can be carried on, after the material has received a preliminary steaming, or air seasoning, therefore depends upon several factors, such as species of wood, its softness and porosity, proportion of heart wood and sap wood, its hardness and density, size, mass, intended use, and the manner in which it is presented to the air in the ovens. No positive rule can, therefore, be given as to the duration of the drying period and the temperature for the various kinds of woods, under all conditions, but experience soon teaches the operator how rapidly the ties or lumber can be dried in the ovens, without injuring it, by splitting, checking, warping or honeycombing.

It should not be inferred from the above that it is necessary to separate railroad ties into groups for drying in ovens, but should it be found desirable to do so, the yard arrangement is such as to render the separation easy. As the time required to obtain sufficient dryness varies, on account of the factors above mentioned, such ties or timbers as have first reached totality of dryness should wait in the ovens for the more refractory timbers. The time required in the ovens to complete the drying of railroad ties, which have undergone the several preceding steps, is about from eighteen to thirty hours, or an average of twenty-four hours.

The drying ovens, as a structure, are preferably built of cement and masonry and correspond in length and size to the length of the impregnating retorts. The air is heated by means of heating coils, placed under or in the bottom of the ovens, and the circulation of the air is effected by means of a blower or fan. Fresh air enters at the ends of the ovens, passes through the heating coils, thence in the oven chambers, thence through the loads or charges on the trams, to the opposite end of the ovens, thence downward into the moist air duct, thence into the moist air gallery, from whence it is drawn out and exhausted by means of the blower. Each oven is adapted to be operated independently of the other, so that when one or more ovens are being charged, the others are not

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affected. The velocity of the air is regulated by means of dampers and a blower or fan. The blower is operated by an engine. One damper for each oven is situated at or near the entrance of the fresh air in the heating chamber and the other at the exit of the moist air into the moist air collection gallery. The temperature of the air is regulated by means of valves situated near the heaters for each oven. Therefore, the velocity and temperature of the air are under absolute control at all times. The free air space between the loads and the cylindrical walls in the ovens is only sufficient for clearance, say about three inches, so that the air will pass through the loads and come in contact with all surfaces of the material, instead of passing around it and drying and warming the exterior more than the interior. At the beginning the temperature of the ovens should be about ninety-five degrees and gradually raised to one hundred and fifty to one hundred and seventy-five degrees F. A maximum temperature of two hundred and thirty-six degrees F. may be attained, with a boiler pressure of one hundred pounds.

In the basement of each oven there is a steel front, with a swinging door, and there is also a small cast iron door in the walls between the working gallery and the moist air gallery. These doors are for the purpose of ventilating the working galleries. By opening the two doors a current of fresh air can be made to pass through the working gallery into the moist air collection gallery.

The transfer from the drying ovens is quickly made by means of a transfer table and no appreciable amount of heat is lost while making the shift from said ovens to the impregnating retorts. It has been popularly supposed that, in operations on a large scale, it would involve considerable expense to move the ties from the steaming cylinders to the drying yards and from the drying yards to the drying ovens, and from the drying ovens to the impregnating retorts, and thereby increase the cost of handling. This is incorrect. On the contrary, by means of the transfer table and the locomotive crane, the cost of handling ties and lumber may be actually reduced in most cases.

Green timber fresh from the saw can be treated as readily as older stock; sometimes apparently more readily, so that preliminary air seasoning may be dispensed with, thus, this system of steaming and drying ties or lumber may be employed with or without a treating plant adjunct.

(e) IMPREGNATING WITH ANTISEPTIC CHEMICALS.

After the timbers have remained in the ovens a sufficient length of time to thoroughly dry and warm them, the trams are drawn out onto a transfer table and immediately run into the impregnating cylinders for chemical treatment. The length of the said cylinders corresponds with that of the drying oven and is capable of holding twelve tram loads of eight foot ties, each tram carrying between forty-five and fifty ties, or approximately five hundred and sixty ties per charge.

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By means (already described) of a locomotive and a transfer table, the shift from the ovens to the impregnating cylinder is quickly made, most of the time under cover, so that the loss of heat would be inappreciable. The heavy cast steel door of said cylinder is then hermetically closed and securely fastened and everything is ready for the treating operation.

The duration of diverse phases of one complete operation, shown graphically on Fig 9, is as follows:

(1)	Charging the cylinder with ties.....	15	minutes.
(2)	Producing vacuum to 14 inches.....	45	"
(3)	Filling cylinder with chemical.....	15	"
(4)	Continuation of filling with pressure pump.....	90	"
(5)	Returning surplus chemical to working tank.....	15	"
(6)	Producing vacuum to hasten drying of ties.....	30	"
(7)	Blowing back last remnant of chemical to working tank	15	"
(8)	Opening door and discharging cylinder	15	"
	Total 240 minutes or four hours.		

In their order the first step is to produce a vacuum up to 14" of mercury and which should be attained within thirty to forty-five minutes. This is for the purpose of withdrawing some of the air from the cells and pores of the wood and inducing absorption of chemical. The vacuum having been on for sufficient time it is held while the chemical is allowed to flow in, which it does very rapidly by the help of the vacuum and by gravity, until the impregnating cylinder is completely filled, it being understood that the chemical, whether it be creosote, chloride of zinc, or a mixture of the two, has been previously heated by means of coils in the respective tanks to a temperature of one hundred and seventy-five degrees F. (The solution pipes from the working tanks are connected to a dome in the bottom of the cylinder.) When the air pressure in the impregnating retort reaches the atmospheric pressure, as shown by the vacuum gauge, an air valve with an overflow pipe attached is opened to let the air escape from the retort, while filling. As soon as the fluid begins to flow in a full stream through the overflow pipe, indicating that the retort is full, the air valve is closed. When the cylinder is filled and the air pipe closed, the force or pressure pump is put into action and kept working until a pressure of say one hundred pounds per square inch is obtained. The more the chemical penetrates into the wood, the more the force pump has to be kept at work to maintain this necessary pressure, and the impregnation is considered complete when the manometer shows, for at least twenty minutes, that without further pumping the pressure has remained stationary at one hundred pounds—thus showing that the chemical is no longer penetrating into the wood.

The duration of this phase of the operation varies from one to two hours, depending upon many factors, such as species of wood, its physical

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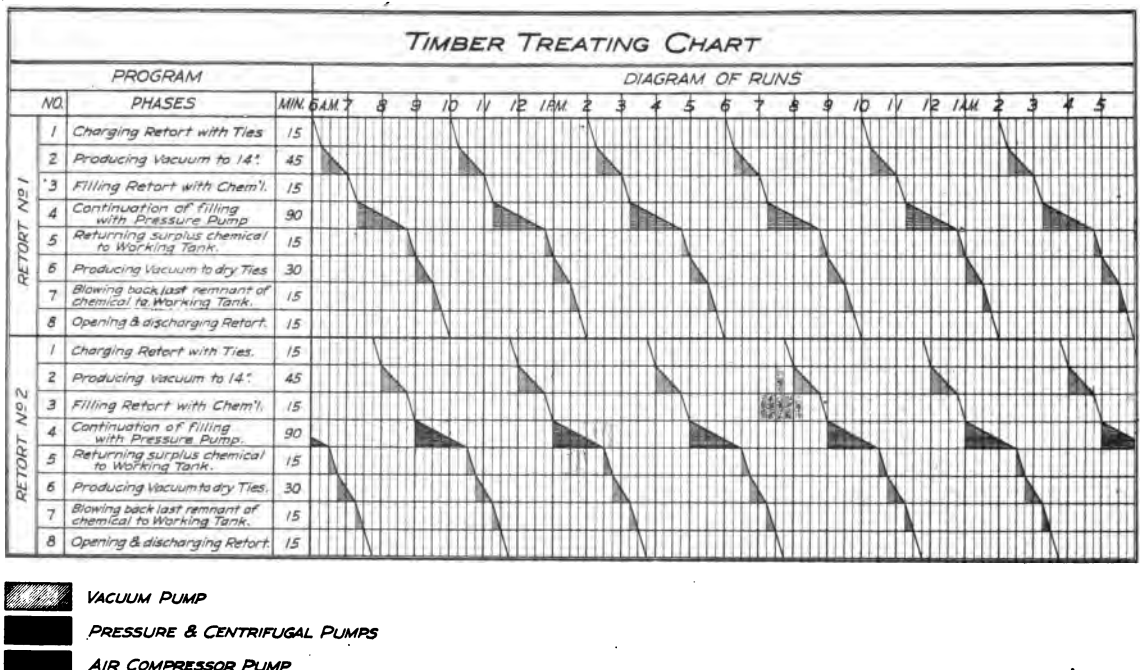
TIMBER TREATING CHART
PROGRAM
DIAGRAM OF RUNS
NO.
PHASES
MIN.
6 A.M. 7 8 9 10 11 12 1 P.M. 2 3 4 5 6 7 8 9 10 11 12 1 A.M. 2 3 4 5
RETORT No 1
1 Charging Retort with Ties. 15
2 Producing Vacuum to 14". 45
3 Filling Retort with Chem'l. 15
4 Continuation of filling with Pressure Pump 90
5 Returning surplus chemical to Working Tank. 15
6 Producing Vacuum to dry Ties. 30
7 Blowing back last remnant of chemical to Working Tank. 15
8 Opening & discharging Retort. 15
RETORT No 2
1 Charging Retort with Ties. 15
2 Producing Vacuum to 14". 45
3 Filling Retort with Chem'l. 15
4 Continuation of Filling with Pressure Pump. 90
5 Returning surplus chemical to Working Tank. 15
6 Producing Vacuum to dry Ties. 30
7 Blowing back last remnant of chemical to Working Tank. 15
8 Opening & discharging Retort. 15
VACUUM PUMP
PRESSURE & CENTRIFUGAL PUMPS
AIR COMPRESSOR PUMP

FIG. 9. TIMBER TREATING CHART BY THE GOLTRA PROCESS.

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structure, proportion of heart wood and sap wood, degree of seasoning, size shape mass, and many other conditions, not a single one of which is sufficiently well defined to make it possible or practicable to segregate timbers into many groups for treatment. The treatment should in all cases be carried to "refusal," which obviates the necessity for sorting ties or timbers into numerous groups, and this is the only way to secure complete and thorough impregnation. The matter of first importance is to secure a thorough penetration. The matter of quantity and cost of antiseptic is a secondary consideration. The pressure should not exceed one hundred pounds per square inch, as it is liable to injure the fibre of the wood. Some experienced operators claim that high pressure splits the wood along the medullary rays and is otherwise detrimental to the fibre of the wood. At any rate, it has been found that high pressure plays only a secondary part, when precaution has been taken to secure thorough and complete seasoning of the ties and previous warming in the ovens to the temperature of the chemical with which they are subsequently treated. The pipe connections between the pumps, tanks and impregnating cylinders are so arranged that straight creosote, straight chloride of zinc, or a mixture of the two ingredients, may be used on one or both cylinders. When a mixture of creosote and chloride of zinc is used, it is kept in agitation in the working tanks by means of steam jets and the fluid is kept in constant agitation in the impregnating cylinder while the pressure pump is working, by means of a circulating system operated by a centrifugal pump.

When the timber has absorbed all of the chemical it can imbibe, the pressure pump is stopped and the solution valve opened. At the same time the air compressor pump, which is connected with the dome on top of the impregnating cylinder, is put into action, pumping air into the cylinder and forcing the excess chemical back to the working tank from which it was originally drawn, through the solution pipes. The solution valves are then closed and thereupon a vacuum is immediately created in the cylinder by means of a vacuum pump. This vacuum, which need not exceed fourteen inches, is held about thirty minutes, or sufficient time to allow the ties to drip. This phase of the operation is for the purpose of removing the surplus fluid remaining on the surface of the ties or timbers, so that they can be handled more comfortably and prevent subsequent dripping, when drawn out of the cylinder. The vacuum reduces the temperature in the cylinder a little, and the cooling and condensing of the remnants of gases and vapors in the wood cells produce a vacuum suction to which is added the force of capillarity, drawing the chemicals deeper into the wood.

When ties or timbers attain a sufficient degree of dryness so that they can be handled comfortably, the vacuum is released and the dripping returned to the working tank, from which it was originally drawn. This is accompanied by a "blow-back" system of piping. The air compressor pump is again put into action, forcing air into the cylinder and at the same time a blow-back valve is opened and the cylinder is thus cleared

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of the last remnant of solution, which is carried to the proper working tank by an overhead pipe. This completes the treating operation. The doors being opened, the tram loads are drawn out and placed on a track in the yard where they are transferred to standard gauge gondola cars, by means of a locomotive crane, for shipment to destination. The next charge being prepared is run into the cylinder, the door closed and the whole operation is repeated.

The pressure pumps are connected with 7,500 gallon measuring tanks, which have gauges operated by floats. In this way the volume of liquid forced into the timber by pressure pump is accurately determined. The working tanks are also provided with gauges operated by floats. The indicators on the tanks are read at the beginning and end of each operation and the difference in the readings gives the volume of the chemicals used.

YARD ARRANGEMENT.

A new and original feature of the plant, as shown in the drawings accompanying this article, is the entire absence of switches for running trams from one part of the yard to the other and shifting of devices from track to track. Frequently the room or space, where a plant of this kind must be located, is limited and precludes the possibility of building a plant of the ordinary kind, with switches. We have planned a yard in which all of the tracks are parallel and relatively near to each other and which are crossed by a transfer table, adapted to move back and forth and serve all tracks abutting thereon. The space required for a plant of this kind is about one-third less than required for the ordinary type. The quantity or length of the tracks is proportionately reduced. The plant is more compact and considerable saving in time and labor can be effected on that account. The maintenance and depreciation of tracks is materially reduced and finally the entire cost of the plant entirely equipped is actually less than that of the plant of the ordinary type, of equal capacity. The reduction of stock of ties necessary to keep on hand, made possible by this improved method, is of very great importance, not only in releasing the capital that is locked up in ties, while undergoing air seasoning, but reducing to a minimum the losses which occur through deterioration of ties, while they are air seasoning.

Ordinarily a plant having a capacity of 1,000,000 ties or upwards, six drying ovens would perhaps be sufficient. However, if it was found that a larger number was required, they could easily be installed in groups of five each, between the double parallel tracks. A plant might therefore be equipped with a sufficient number of drying ovens to receive all the ties and dispense with the open air treatment, but the original cost of the plant would necessarily be proportionately increased.

At some future time we will give a full description of the mechanical appliances and equipment, used in connection with a plant, such as we have described.

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APPROXIMATE COST OF PLANT.

The cost of the plant as illustrated and described in this article, completely equipped, exclusive of land, would be approximately as follows:

FOR PLANT.

Four miles of track and grading	$20,000.00
Six drying ovens with heating and ventilating apparatus and iron work, complete	16,000.00
Two steaming cylinders, saddles, piping, etc., installed	8,000.00
Two impregnating retorts, saddles, pipe connections, heating coils, etc., installed	12,000.00
Three 150 H. P. boilers set, complete	4,200.00
Iron, steel and wooden tanks, complete	10,400.00
Transfer table, electric motor, etc., installed, complete	5,500.00
Brick buildings, including machine shop	18,000.00
Sewers	1,500.00
Pumps, air compressor, vacuum, pressure, general service, etc.	4,600.00
Piping, solution pipes, steam pipes, air pipes, valves, etc., installed complete in retort building	5,800.00
Fire hydrants and piping complete	2,500.00
Electric plant and generator, wiring, etc., complete	3,000.00
Scales, creosote and zinc chloride wells, driven wells, and miscellaneous items	4,000.00
	$115,500.00

FOR EQUIPMENT.

One twelve ton locomotive crane	$ 4,500.00
One switch engine 10 x 16 cylinders	3,000.00
200 tram buggies	9,000.00
Adzing and boring machine, mounted on 40 foot steel underframe car, exhaust fan, air compressor, complete	10,000.00
	$26,500.00

RECAPITULATION.

For plant	$115,500.00
For equipment	26,500.00
Total	$142,000.00

In addition to the above it is necessary to carry a stock of creosote oil and zinc chloride, which would perhaps amount to $30,000.00 on the average the year round. The above plant can easily treat 1,500,000 ties annually, with reasonable allowance for breakdowns and interruptions, provided it is operated night and day. In the event 1,500,000 ties or more a year were treated, it would probably be necessary to add two units of five each, or ten ovens to the plant, which would cost approximately $25,000.00. It will be observed that such a plant requires only about twenty acres of land and the tracks amount to only four miles. Furthermore there is no need of a loading platform, as the ties are transferred from tram cars to gondola cars with a crane, from the ground level. This saves approximately $3,000.00 in the installation of a plant.

W. F. GOLTRA.

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(PAPER READ BEFORE THE EIGHTH ANNUAL MEETING OF THE WOOD PRESERVERS' ASSOCIATION IN CHICAGO, JANUARY 16-18, 1912.)

TREATING SEASONED vs. UNSEASONED TIES.

By F. J. ANGIER,
Superintendent Timber Preservation B. & O. R. R.

Naturally, the first question which would arise in a subject of this kind is: What is a seasoned tie? When we speak of an unseasoned tie, we mean one freshly cut, or, at least, one that has been recently cut and lost but a very small amount of the moisture which it originally contained: in other words, the sap wood is so completely filled with moisture that it would be impossible to thoroughly treat the tie until this moisture had been at least partially removed. A seasoned tie, therefore, is one that has been cut for some time and the moisture allowed to evaporate to a greater or less degree.

The time necessary to season a tie so that it can be properly treated varies in different localities, as well as in different seasons. The kind of wood also is of considerable importance. Oak ties, in Illinois, must be air-seasoned six months or more, according to the time of year, before they can be properly treated. Some kinds of ties may be seasoned in three or four months.

For the purpose of illustration, and as a basis for argument, we will assume that it requires six hours to treat a charge of thoroughly seasoned ties and nine hours to treat a charge of unseasoned ties. In other words, it requires one-half longer time to treat unseasoned ties. Of course, the time may vary one way or the other, but we found this to be a fair average. (It should be stated here that the treatment referred to is with a mixture of creosote and zinc chloride, known as the Card Process.)

Assuming this to be correct, your attention is respectfully called to the two tables following, one showing the cost of treating in a plant having a maximum capacity of 1,800,000 seasoned ties a year, and the other the cost of treating in the same plant, where the maximum capacity is reduced to 1,200,000 unseasoned ties a year.

SEASONED TIES.

Capacity of Plant, 1,800,000 Per Year.

Unloading from cars to ground to season at $0.0070 each	$ 12,600
Loading from ground to trams at $0.0055 each	9,900
Switching trains at $0.0020 per tie	3,600
Loading treated ties out at $0.0065 each	11,700
Fixed expenses	23,268
Preservatives at 15c per tie	270,000
Fuel (assume ⅓ less for seasoned over unseasoned ties)	5,600
Insurance carried on 1,000,000 ties (estimated)	4,000
Interest on 1,000,000 ties for six months, or 5 per cent on $250,000	12,500
	$353,168
600,000 more seasoned ties treated than unseasoned, worth $0.044 each (see statement)	26,400
$0.1815 per tie.	$326,768

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UNSEASONED TIES.

Capacity of Plant, 1,200,000 Per Year.

Unloading one-fourth from cars to ground to enable prompt releasing of cars, at $0.0070	$ 2,100
Loading 900,000 ties from cars to trams at platform and 300,000 ties from ground to trams as $0.0055	6,600
Switching 300,000 ties from yard to retorts at $0.0020	600
Loading treated ties out at $0.0065 each	7,800
Fixed expenses	23,268
Preservatives at 15c per tie	180,000
Fuel	8,400
Insurance carried on 300,000 ties (estimated)	1,200
Interest on 300,000 ties, or 5 per cent on $75,000	3,750
	$233,718

$0.1948 per tie.

In each case the total cost of handling is shown from the moment the ties are received at the plant until they are loaded into cars for shipment.

In the case of fixed expenses there are included the salaries of the superintendent, general foreman, office force, engineers, firemen, etc., that is, all labor which would not change one way or the other, whether treating seasoned or unseasoned ties. This amounts to $0.0129 per tie when treating 1,800,000 ties a year, and $0.0194 when treating 1,200,000 ties a year.

In the case of seasoned ties, where no steaming is done, it is assumed that insurance is caried on 1,000,000 ties for six months and that $250,000 will be continually invested at 5 per cent.

In the case of unseasoned ties, we must assume that at least 300,000 will always be in the yard. This stock is necessary to provide against delay to plant as certain times of the year, when traffic is so great that company material can not be moved with regularity. Also, at certain times of the year, ties will be received faster than they can be treated, necessitating the storing of a portion of them.

It is shown in the table that a treated tie is worth $0.044 to the company. This is obtained as follows:

UNTREATED TIES.

First cost	$0.50	
Cost of putting in track	.15	
Cost of tie in track		$0.65
5% interest on investment for six years		.195
Second renewal, end of six years		.65
5% interest on first investment for six years, and on second investment for six years		.39
Total cost of tie for period of 12 years		$1.885
Average cost per tie per year		$0.157

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TREATED TIES.

First cost	$0.70
Cost of putting in track	.15
Cost of tie in track	$0.85
5% on investment for 12 years	.51
Total cost of tie for 12 years	$1.36
Average cost per tie per year	$0.113

Saving per tie per year $0.044.

Untreated ties are assumed to last six years, and treated ties twelve years.

Assuming this to be reasonable, and that 600,000 more ties a year can be treated when thoroughly seasoned, deduct from the cost of seasoned ties the difference between 1,800,000 ties and 1,200,000 ties, or 600,000 ties, at $0.044 each. We have a difference of $0.0133 per tie in favor of treating seasoned ties. This multiplied by 1,800,000, the number of seasoned ties treated a year, represents a saving of $23,940 in favor of seasoned ties.

In addition there would be a better penetration of the preservatives; therefore a longer life obtained for the ties and the lessened possibility of injury to the wood by steaming. When steaming there is always a large amount of sewage to dispose of, while in non-steaming there is practically none. The disposition of sewage is a difficult problem at most plants, because no matter how it is handled some of it will get into the rivers or creeks and pollute the water to such an extent that damage suits may result. This is entirely avoided when using seasoned ties.

(PUBLISHED IN THE RAILWAY AND ENGINEERING REVIEW, FEBRUARY 10, 1912.)

February 3rd, 1912.

Editor, Railway and Engineering Review:

Among the papers presented at the American Wood Preservers' Association and printed in your issue of January 20th, there is one from Mr. F. J. Angier, superintendent of timber preservation, of the Baltimore & Ohio Railroad, on "Treating Seasoned vs. Unseasoned Ties." The discussion of this paper was omitted for lack of time and I desire to make some comments on it, through the columns of your paper.

While not specifically so stated, the impression left on my mind after reading this paper, and I think on that of most readers, is that no economy is effected or advantages derived by steaming ties prior to impregnation, but upon careful examination of the paper and through correspondence with Mr. Angier, I learn that it was not his intention to convey that impression. He writes "I am simply comparing air seasoned ties with absolutely green ties or freshly cut ties that come to the plant and which would have to be steamed in the same cylinder in which they were treated."

Mr. Angier was discussing the question of steaming and treating ties in the same cylinder, and his conclusions, so far as I understand,

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are not against the principle of steaming ties and timber, but against the method of steaming and impregnating ties and timbers in the same cylinder. When the steaming and impregnating is done in separate cylinders it tells a very different story.

There is another clause in Mr. Angier's paper which might perhaps be misunderstood. He says in discussing seasoned ties: "In addition there would be a better penetration of the preservative; therefore, a longer life obtained for the ties." By this I understand that he means that unless the ties are air-dried after the steaming, so as to remove the condensed water and vapor in the pores and cells, the entrance of the chemical into the wood will be obstructed. That is quite correct. Experience has demonstrated that it is not feasible to impregnate timber with antiseptics immediately following the steaming, because the cells and pores are usually filled with water or condensed steam, which resists the entrance of the chemical. A fair penetration can be obtained with zinc chloride, because it is a water solution, but scarcely any can be obtained with creosote oil. Therefore it is very essential that ties and timbers be air dried after the steaming in order to remove the water or condensed steam from the pores and cells of the wood.

I grant that it is neither economical or feasible to steam and impregnate ties and timbers in the same cylinder, but when this is done in separate cylinders the result is quite different. To illustrate, let us assume that the cost of treating ties by the Card process (zinc chloride, combined with creosote oil) without preliminary steaming, is 20 cents and the life an average of 12 years. Also let us assume that the cost for steaming and treating ties by the Goltra and Card processes would be likewise 20 cents per tie, and the life thereby increased one year on account of the steaming and subsequent air drying. The comparison would be as follows:

FIRST METHOD.

Cost of ties	$ .50
Cost of treatment	.20
Laying in track	.15
Total	$ .85

Lasts 12 years. Annual charge (from published tables), .0901.

SECOND METHOD.

Cost of ties	$ .50
Cost of treatment	.20
Laying in track	.15
Total	$ .85

Lasts 13 years. Annual charge (from published tables), .0850.

The difference in the annual charge is .0051 per tie per year. Multiplying this by the average number of years, which in this case is 12½ years, gives .0637 or 6⅜c per tie, which represents the relative economy of the two methods. Should 1,800,000 ties be treated annually this saving or gain by steaming ties and subsequent air drying, would amount to $115,000. To this should be added the interest on net reduction of

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stock made possible by artificial seasoning; insurance, taxes, etc., which we estimate amounts to not less than $35,000 in the case under consideration, making a total of $150,000 gained or saved by steaming of the ties, which is enough to build and equip a plant every year. This seems almost incredible, but it becomes clear when figures and estimates are brought down to a measurable basis.

If it be granted that steaming and subsequent air drying of ties will put them in better condition to absorb the antiseptic, and thereby obtain a better penetration and dissemination of the chemical, and consequently increase the average life of the ties to the extent of one year only, then the statements I have made above are correct. The definite amount gained or saved by steaming of ties is a simple arithmetical problem, after agreeing upon the premises. The cost of steaming and treating ties in the same cylinder is just about the same as doing the work in separate cylinders; in fact, by means of labor and time saving appliances, suitable yard arrangement, etc., the cost of handling of the ties, which constitutes the bulk of the expense, can be actually lessened.

We should not lose sight of the fact that Mr. Angier is simply comparing ties steamed and treated in the same retort, which would, of course, reduce the output of a plant that treated ties in this manner; but if the plant is so constructed and provided with separate steaming cylinders, ties can be steamed simultaneously with those that are undergoing treatment and the output of the plant, therefore, would not be curtailed.

I think it is generally conceded that the steaming of ties or timbers prior to impregnation is essential to secure good treatment. For a period of twenty years after tie treating began to be practised extensively by several railroads in this country, steaming was used invariably and also very extensively, if not invariably, in foreign countries. Six or eight years ago the practice was discontinued in this country, in some places, particularly where creosote treatment was employed, not because steaming was considered useless or ineffective, but mainly for other reasons, such as expense, probable injury to the timber and difficulty of impregnating timber with creosote oil. However, all of these objections can be readily overcome by the application of proper methods of treating with suitable facilities.

Finally, Mr. Angier says that the disposition of the sewage is a difficult problem. This is perhaps true when the steaming and treating is done in the same cylinder, but it is not the case when the work is done in separate cylinders. In the former method the extracts of the wood are mixed with the poisonous chemicals and would pollute the streams if they were turned into them. On the other hand, saps and juices extracted by steaming of wood in separate cylinders would be free from poisonous substances, and therefore not objectionable, and could be turned into the streams like other sewage, provided no use could be made of the extracts. Perhaps it may be found that the extracts have some value as a byproduct.

W. F. GOLTRA.

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FROM A PAPER BY J. H. WATERMAN, SUPERINTENDENT OF TIMBER PRESERVATION, CHICAGO, BURLINGTON & QUINCY R. R., AT GALESBURG, ILL., PRESENTED AT THE ANNUAL CONVENTION OF THE WOOD PRESERVERS' ASSOCIATION, CHICAGO, JANUARY 18, 1912.

YARD FOR PILING TIES AND TIMBERS AT A TREATING PLANT.

This proposed design of yard for piling ties and timbers, Fig. 10, is an evolution of the present arrangement of the C. B. & Q. R. R. yard at the Galesburg treating plant. The design has been studied out primarily for the piling of the material and not for the arrangement of a treating plant. The following data pertain to its capacity: It covers 95 acres of ground, has 10½ miles of standard gauge track, and has room for piling 1½ million cross ties, 15 million feet of lumber, besides 12,000 pieces of piling 16 to 54 ft. in length. I have designed it in a manner to permit extensions, or it can be shortened or narrowed to suit desired capacity, without disarranging the facilities.

The illustration shows a yard at the east end of the layout, so as to secure an independent lead for switching cars without interference with the main part of the yard. On the west end there is a lead where 25 to 30 cars can be switched. For instance, No. 1 track is practically 4,500 ft. long. If it is desired to put a string of cars on it, the engine might not be able to handle 75 cars at one pull, or it might be desired to cut the train in two and switch from the east end. In that case the engine would swing through the running track, No. 5, and switch from the west end and put the remainder of the cars where they are wanted.

The sharpest curve is 16 deg. The frogs are all No. 7. The curves are not so sharp at the east end. I want to especially call attention to the arrangement of the platforms and the standard gauge tracks running on either side of them and the convenience in switching on them. Track No. 5 is the running track and Nos. 6 and 7 are storage tracks for empty cars.

For convenience we will refer to the platforms as the north platform and the south platform. We will assume that the cars, which have been set to the loading platform, are loaded and ready to be pulled out. The switch engine would come through track No. 5 and pick up the cars on the south side of the south platform, back up, pick up the cars on the north side of the south platform and pull down on No. 5, cut off, go to the west end down through track No. 6, pushing the empty cars, filling up the south platform, first on the south side and setting the remainder on the north side. It would then back up and go in on the south track of the north platform, pick up the cars and go on in on the north track of the north platform, pull back on track No. 6, cut off, go to the west end of track No. 7, pushing the empty cars in to the north platform, first on the south side and then on the north side; then cut off, pick up the loads on track No. 6, pull east, pick up the loads on track No. 5 and take them out to the main yard.

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Fig. 10

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There are three-rail cross-over tracks in the east end of the yard. These are designed for a standard gauge engine to push the loaded trams up to the retorts, and it will be noted that the trams can be pushed up to the retorts from the south side of the yard, or from the north side of the yard; and the arrangement is so designed that a charge of ties can be pushed from either north or south in either of the six retorts. The platforms are raised and we use hoisting engines for filling the retorts and also for taking ties out of the retorts and placing them on the platforms for loading out.

I would call attention to the design on the west end of each platform of the narrow gauge tracks. An empty tram car can be dropped from the south platform, north or south, and the same thing can be done from the north platform, north or south. If a narrow gauge engine is used to push the trams the platform would be built on the level and have depressed tracks. With a standard gauge engine I prefer the raised platform. However, that question does not affect the general line up or arrangement of the yard.

There are three narrow gauge tracks, which I term "hold-over" tracks, two south of the south platform and one north of the north platform. This yard is designed to have a place for everything and to try and have everything in its place. Gentlemen connected with plants or material yards know that the expense of switching depends largely on how many times one must move a car before releasing it. You will notice a track for creosote and zinc chloride, a track for coal, a track for cinders, a track for the coaches and a track for derricks.

For piling ties we have a three-rail track. I think the three-rail tracks are more practical than a narrow gauge track on one side. In the first place, they save space. One does not have to go so far to carry the ties from the standard gauge cars when unloading them and it is not so far to carry them to the tram cars when loading them up. This is true at least of half of the ties piled along the tracks used for ties. The design permits a standard gauge engine to push the trams to the retorts, so that they can be reached with the cable of the hoisting engine.

If this was a new yard, just designed, I would put the ties in on No. 1 track. I would fill that up, that is, I would pile all the ties on No. 1 track that it would hold; then I would go to track No. 2, then No. 3, then No. 4, then to No. 11 and No. 12. Then when I started to treat, the first ties I would clean up would be those on No. 1 track entirely, before I went to track No. 2. When I unloaded the ties on track No. 2 I would begin to unload the ties on track No. 1. Then I would have this part of the yard for what we call the "dose" or the cars that come in every day. When I would get through treating the ties on track No. 2 I would go to track No. 3, then I would fill up or pile the ties on track No. 2, and so on through.

It is feasible to set from 50 to 75 cars to be unloaded at one time on any of the tracks intended for ties. The ideal way to unload is to begin, say, at the east end and unload to the center, then go to the west

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end and unload to the center, and while unloading on the west end the empty cars on the east end can be pulled out and reset with loads, and the same is true with the west end. After the cars have been emptied they can be pulled out and loads can be set in while the cars on the east end are being unloaded and handled. We unload all of our ties by piece work.

We pile our ties by what is known as "1 to 8" arrangement. We pile them four tiers back from the standard gauge track, and some of them are piled twenty high. You will ask "Can you pile them all twenty high?" I will be frank with you: When we have lots of the ties and few men we let the men pile them low and when we have few ties and lots of men we make them pile them high. We regulate the matter as the ties come in.

In some cases we have a narrow gauge track on one side of the standard gauge track, so that a crane can be used in loading the trams. When using a crane it is necessary to have the track clear. It is not practicable to load piling and lumber on tram cars with a crane on a three rail track. By having a narrow gauge track on one side, the lumber or piling can be taken from the piles and loaded onto the trams, and when one is loaded the next tram can be taken up, and so on until all the trams are loaded.

You will note we have the lumber in the center of the yard instead of one side. The reason for so designing the yard is because lumber often comes in long lengths. We handle our piling from 16 to 54 and 60 ft. lengths and we avoid sharp curves in getting to and from the retorts. In other words the tracks for this material are more nearly straight and there are fewer curves to overcome. We handle piling, switch ties and all heavy lumber with cranes.

(PUBLISHED IN THE RAILWAY AND ENGINEERING REVIEW, APRIL 13, 1912.)

Cleveland, Ohio, April 3rd, 1912.

Editor, Railway and Engineering Review,
Chicago, Ill.

The plan showing a proposed layout for wood preserving plant, published in your issue of March 9th, which was presented by Mr. J. H. Waterman, Superintendent of Timber Preservation, C. B. & Q. R. R., is remarkable at least in one respect, namely, its enormous size. Aside from this, the design does not present any novel features that we can discover. No scheme is submitted whereby economy of time and labor necessary for handling ties and timbers can be effected, nor any suggestions that would tend to improve the quality of treatment, over that of any methods in vogue. Although his plan may not be the present arrangement of the C. B. & Q. at Galesburg, Ills., which as is well known possesses several undesirable features and in consequence of not being properly laid out is an expensive plant to operate, yet there is apparently no material difference between the two designs. The design that Mr.

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Waterman has proposed as an ideal does not correct the faults and deficiencies of the Burlington plant, which time and experience have revealed.

He says, "This proposed layout covers ninety-five acres and requires ten and one-half miles of standard gauge track." From a cursory examination of his plan, we find that this includes approximately four miles of three-rail track, but in addition there is approximately four and one-half miles of narrow gauge track, making in all fifteen miles of track. Assuming the average cost of building these tracks, of various kinds, at $5,000.00 per mile, they would cost in the neighborhood of $75,000.00. To this should be added the cost of grading, which we estimate at $10,000.00. Also frogs, switches and crossings, as listed below, estimated to cost $15,000.00. Mr. Waterman estimates the cost to build these yard tracks complete, except grading, at $100,000.00. It should be borne in mind that this amount is for tracks only, the treating plant proper would cost an additional $150,000.00. We understand that the cost of the Burlington plant complete was upwards of $250,000.00. We observe that the design or arrangement of yard as proposed requires a very large number of frogs, switches and crossings, as follows:

32 frogs for standard gauge track.
32 switches for standard gauge track.
16 frogs for combination standard and narrow gauge track.
16 switches for combination standard and narrow gauge track.
58 frogs for narrow gauge track.
58 switches for narrow gauge track.
28 crossings for narrow gauge with narrow gauge track.
10 crossings for narrow gauge with standard gauge track.
6 crossings for narrow gauge with three-rail track.
5 crossings for three-rail with three-rail track.

An examination of the design will convince anyone acquainted with track construction that there are many problems in complicated and highly expensive work here presented, and we venture to say that should an engineer attempt to work up the details of this extensive net work of tracks, he would discover that the design presents mechanical difficulties, that would necessitate radical changes, and would undoubtedly come to the conclusion that the expenditure of so much money in track material could be more profitably employed in other ways. With proper arrangement of yard tracks and with adequate facilities for handling ties and timbers, the area of the yard, amount of trackage, and number of frogs, can materially be reduced without decreasing the capacity of the treating plant. The writer designed a treating plant, that has nearly the same capacity as shown in Mr. Waterman's plan, which requires only four miles of track, fourteen frogs and fourteen switches, no crossings, and the aggregate cost of the tracks complete being approximately $24.000.00. and the area of land required is only twenty acres.

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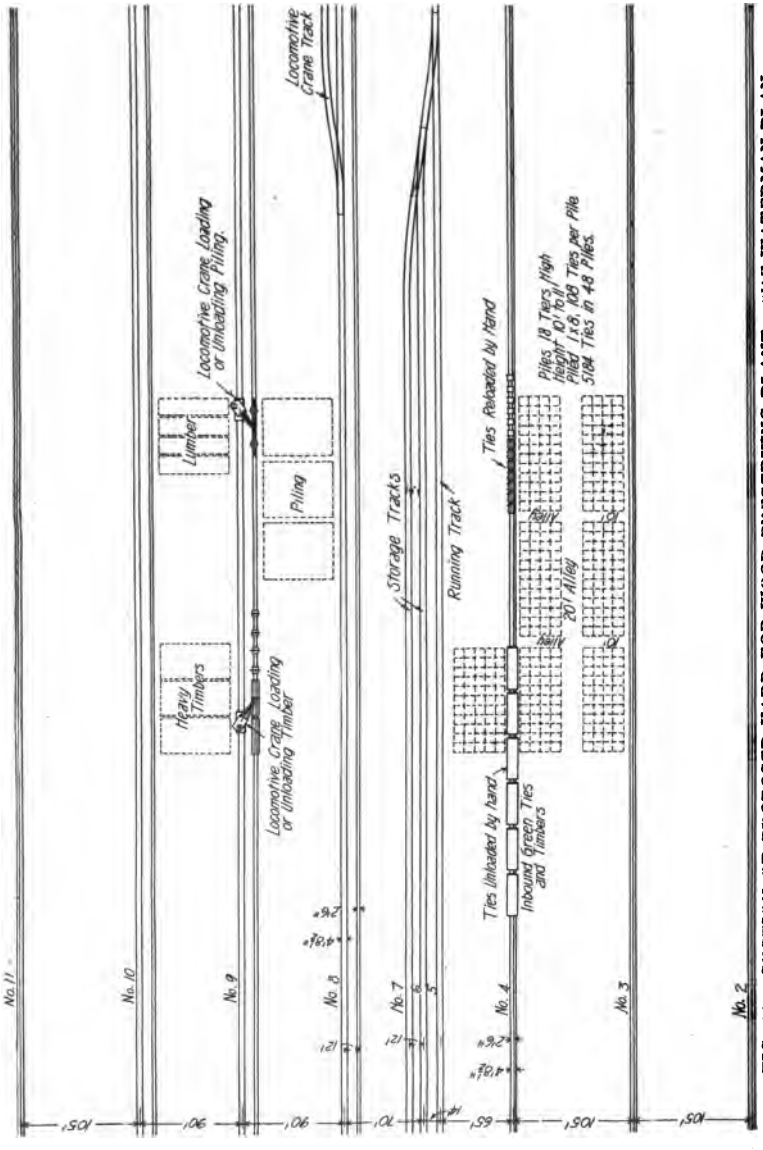

FIG. 11. SECTION OF PROPOSED YARD FOR WOOD PRESERVING PLANT—THE WATERMAN PLAN.

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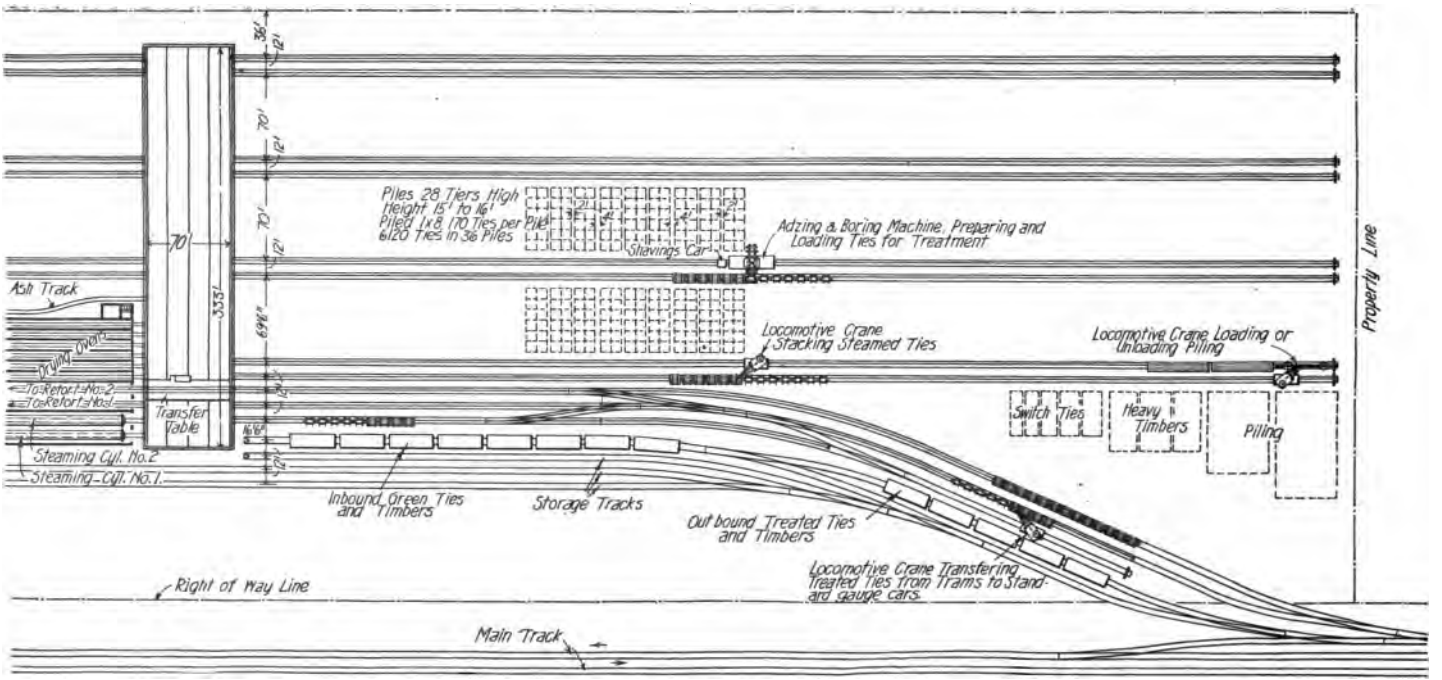

FIG. 12. SECTION OF PROPOSED YARD FOR WOOD PRESERVING PLANT—THE GOLTRA PLAN.

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Would it not be wiser to expend this difference in the cost of yard tracks, amounting to $76,000.00, for something that would both reduce the cost of operation and improve the quality of treatment? In our opinion, the money could be better employed by putting it into equipment, such as steaming cylinders, drying ovens, locomotive cranes, tram buggies, adzing and boring machine to prepare ties for treatment, transfer table and other facilities, which would lessen the cost of labor in handling the material and greatly enhance the quality of treatment.

Mr. Waterman's plan shows two elevated platforms, each 500 feet long, or 1,000 lineal feet, which we estimate would cost approximately $6,000.00. Wherever ties are handled with locomotive cranes, there is not any necessity for elevated platforms or depressed tracks. Ties and timbers can be loaded into box cars, stock cars, or gondola cars, with a locomotive crane, more expeditiously and economically than it can possibly be done by hand from elevated platforms or depressed tracks. It was our privilege recently to watch the loading and unloading of cross ties with a locomotive crane at the American Creosote Works, New Orleans, La., and we were impressed with the rapidity and ease with which the work was done, and venture to say that the cost of handling these cross ties at the New Orleans Plant is very much less than at the Galesburg plant. Practically all of these ties were received and shipped in box cars.

In order to convey clearer understanding of the two methods of stacking ties and timbers for air seasoning and then reloading on trams for treatment, we present the two accompanying drawings, Figs. 11 and 12, made to the same scale, showing the arrangement of yard tracks and facilities for doing the work. According to Mr. Waterman's plan the tie storage tracks, which are all three-rail, are laid single, while in our plan they are laid double. Our arrangement admits stacking of ties and timbers on both sides of these tracks with a locomotive crane. The other plan does not admit of this, except for timber. Mr. Waterman favors the use of a locomotive crane to pile heavy timbers, but not for cross ties. Cross ties constitute perhaps ninety per cent of the material treated at railroad plants. He evidently recognizes the economy effected by using the locomotive crane for handling timbers, as he remarked at the annual meeting of the American Wood Preservers' Association, in 1911, in speaking about stacking or piling, "You will note that we pile them 20 high. Some say this is very expensive. Not so with a good up-to-date crane. You would be surprised how cheaply we pile them—average of five cents per stick." If piling and heavy timbers can be handled so economically with a modern crane, why not handle cross ties in the same way? With a proper yard arrangement, as we have proposed, it can be done. By our method the tram loads of ties are brought from the steaming cylinders and placed on either one of the double three-rail tracks. The locomotive crane, which is standard gauge, is set upon the opposite track. The crane is equipped with a hook that grips four ties at a time. The cranesman lowers this hook to the tram load of ties and when it has gripped four ties he deposits them on the stack. One or two men stand

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on the stacks to guide and straighten the ties into place. If desirable it is possible to lift the entire tram load, consisting of fifty to sixty ties, by passing chains around the ends of the load of ties and hoist them bodily and deposit on the stacks. The unloading and stacking of ties can be accomplished with marvelous rapidity, ease and economy, with a locomotive crane. On the contrary with such a yard arrangement and method as proposed by Mr. Waterman, it is necessary to unload the ties from box cars, one at a time, by hand, carry them sometimes long distances and up on high stacks, a method that is slow, laborious and expensive.

As to the method of piling ties in the yard: According to Mr. Waterman's plan, the ties are stacked in solid blocks of four piles deep and twelve piles long, with an alley twenty feet wide between the blocks. They are usually stacked one by eight, eighteen tiers or between ten to eleven feet high, 108 tiers in a pile, 5,184 ties in a block. In our plan ties are stacked in open blocks of 36 piles, six each way, with a four foot alley between the blocks and a two foot alley between every two piles, so that one end of every pile is exposed to the air. The stacking is one by eight also, but the stacks are carried up twenty-eight tiers, or fifteen to sixteen feet high, 170 ties in a pile or 6,120 ties in a block. The stacking can be carried up higher with a locomotive crane than can be accomplished by hand labor.

Mr. Waterman says, "In piling ties we have a three-rail track. I think three-rail tracks are more practical than narrow gauge tracks on one side. In the first place they save space." This is true, however, a double track three-rail system, which permits the use of a locomotive crane, is more economical of space, because the ties can be stacked much higher. Let us do a little figuring. In a space or block 105 feet by 110 feet or 11,550 square feet, Mr. Waterman piles 10,368 ties, which is equal to one and one-tenth square feet of space per tie, whereas in our space or block of 82 feet by 59 feet or 4,838 square feet, we pile 6,120 ties, which is equal to only eight-tenths of a square foot of space per tie, or twenty-seven per cent less. Therefore, the saving of space is in favor of the double track system.

A large reduction of area and trackage can be effected by the use of the transfer table for switching cars and trams at plants or this character. Mr. Waterman says, "Gentlemen connected with plants or material yards know that the expense of switching largely depends upon how many times one must move the car before releasing it." This is true, and he might have added, the distance that the cars and trams have to travel affects the expense for switching. A large reduction in the number of times a car or tram has to be moved and the distance it has to be hauled before it is released, can be accomplished by the use of a transfer table to do the switching, instead of performing that service in the old way of running switches with a locomotive. The transfer table is a great time and labor saver. Trams of ties or timbers can be placed in the steaming cylinders, ovens, or impregnating retorts in much less

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time with a transfer table than it would take to travel with a train of trams over a mile or more of tracks and through a net work of switches. Standard gauge cars can also be shifted by means of a transfer table to any track in the yard, if desired, although it would be seldom that such cars would be placed in the tie storage yard. The transfer table is not only more expeditious and more economical, but also reduces to a minimum the time that retorts may be idle. When switching is done in the ordinary way, there are frequently many delays.

The double track three-rail arrangement affords another very important advantage. It admits the use of an adzing and boring machine, mounted on a standard gauge car, for machining and conditioning the ties for treatment. The car can be moved about the yard, from point to point and placed opposite the stacks of ties. The car is set on one of the double tracks in front of the pile of ties that are ready for treatment and empty trams are set upon the opposite tracks. An endless chain conveyor is placed between the stacks of ties and the car, and a skid is placed between the machine cars and the tram car, on the other side. The conveyor between the machine car and the stacks of ties is raised or lowered to suit the heights of the stacks. Thus the ties are loaded on trams at the same time that they are machined and it might be said are loaded mechanically. This method is much speedier and less laborious than when performed by hand labor. The ties pass through the machine at the rate of 200 per hour. The cost of taking the ties from the pile, machining and loading them on trams, is approximately two cents per tie. Mr. Waterman's plan with single three-rail track does not afford this advantage.

Another serious objection to Mr. Waterman's layout in yard is the difficulty met with in attempting to sort the ties or timbers into groups for treatment, in the yard. There are a good many engineers who conscienciously believe that all ties and timbers should be grouped according to species, proportion of heart wood and sap wood, degree of seasoning, sawn or hewn, etc., before treatment. While we do not think it is necessary to separate the ties into groups for treating efficiency, yet it is often necessary to separate them for commercial economy, for instance, white oak and chestnut are usually separated from beech, red oak or other treatment ties; cull ties separated from good ties; eight foot from eight and a half foot ties; sawed from hewed ties; and hardwood from softwood ties. But such separations are for commercial economy and not for treating efficiency. In any event our track layout admits of any grouping or segregation of the timber that might be necessary, as will be observed by examination of our design. The incoming green ties, which are usually loaded in box cars, are delivered on a track, as shown on plan. Alongside of this track the empty trams are placed. The transferring of the ties from the standard gauge cars to the tram cars is performed by hand or by conveyor, and any sorting or grouping that is found necessary can be accomplished easily and economically. It has not been found practical to group ties and timber as they are loaded on cars at points of shipment and such grouping as experience may teach us is

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necessary in order to secure good treatment of the material should be performed at the plant. The American Railway Engineering Association have evidently recognized this fact, as at the last meeting they adopted the following recommendation of the Committee on Wood Preservation: "The separation in the yard on the basis the ties are to be grouped for treatment, is an essential and economical practice." Mr. Waterman's layout makes it extremely difficult to sort ties into groups in the yard, as one can readily observe by examining his design. By our method it is just as easy to sort the material as not and no extra work or cost is entailed, as the separation can be made as the ties are loaded on the trams.

Mr. Waterman says he would fill up the tracks numbered 1, 2, 3 up to 12 and when he started to treat he would clean up the tracks on the same order. He would then totally disregard the different lengths of time the various species of timber require in ordinary air seasoning, to put them in condition for treatment. It is a well known fact that some timbers take longer to season than others, for example, beech requires six to eight months, red oak ten to twelve months. Again climatic conditions influence the rate of seasoning; ties season faster in Summer than in Winter. Thus no attention is paid to the seasoning, which is one of the principal factors influencing the penetration and absorption, but he would clean up the ties in rotation no matter what their moisture condition might be.

The method of treating ties and timbers, which has been in vogue at Galesburg, necessitates the carrying of large stock of material on hand for air seasoning. We estimate that the value of the material which Mr. Waterman anticipates to carry on hand is in the neighborhood of $1,300,000.00. This enormous stock can be greatly reduced by giving the material a preliminary steaming upon arrival at the treating plant. The period of open air seasoning of hardwoods can thereby be shortened from an average of nine months to an average of three months, consequently it would not be necessary to carry on hand more than one-third of the stock mentioned by Mr. Waterman and would release about $867,000.00 of capital locked up in stock on hand undergoing air seasoning. As Mr. Waterman is an ex-Storekeeper, he no doubt realizes the importance of keeping down the amount of stock on hand to the lowest notch, commensurate with the needs of the railroad. Steaming effects other economies besides that just mentioned. It lessens the loss through deterioration of ties while undergoing air seasoning; it puts the material in a more receptive condition to receive the antiseptic, consequently a better penetration and dissemination of the chemical in the wood is obtained; taxes and insurance are correspondingly lessened with reduction of stock on hand; cost of maintenance of tracks is greatly reduced, as much less trackage and storage room are required by this method. For thorough work, steaming cylinders and drying ovens are absolutely indispensable and the yard arrangement should be so designed as to bring these adjuncts into close working relation with the other parts of the treating plant.

W. F. GOLTRA.

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Some Facts

About

Treating Railroad Ties

Part III.

Essentials for Effective Work in Timber Treatment

By

W. F. GOLTRA

PRESIDENT, THE W. F. GOLTRA TIE COMPANY

CLEVELAND, OHIO

1913

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PREFACE TO PART III.

The booklet entitled, "Some Facts About Treating Railroad Cross Ties," published two months ago, has met with such favor and demand that the Author concluded to collect in a convenient form some editorials and correspondence which appeared in the Railway and Engineering Review, in the months of November and December, 1912, and make it Part III of his treatise on treating railroad ties. The questions of "Mechanical Life of Ties" and "Essentials for Effective Work in Timber Treating" are discussed and it is hoped the information contained in this pamphlet may be found interesting as well as instructive to the reader.

THE AUTHOR.

Cleveland, Ohio, January 10th, 1913.

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(EDITORIAL FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 2, 1912.)

THE SHELL GAME IN TIMBER TREATMENT.

Evidence of malpractice in timber treatment continues to appear. An engineer writes us that he was "just in from a three weeks' bridge inspection trip, and some of the developments of treated timber have been eye openers" to him. He then goes on to tell about shallow penetration of the preservative in bridge timber that came under his observation, decay having well progressed in some of the creosoted piles after a service as short as only four years.

It is regretful that, considering past experience in this country, such reports of creosoting work should be possible. It is not so long ago, when timber was cheaper, that creosoting of railroad ties and other timbers was but little practiced in this country, being put out of consideration because of the cost, and for that reason only. Because of the predicted increase in price of timber, however, engineers looked forward to the time when creosoting, which was much more expensive than other forms of timber treatment then in vogue, would become an economical practice. Judging from the long use of creosoting in Europe it was generally understood to be the best known method of treating timber for protection against decay. This view was so generally accepted that no question was raised as to the superiority of creosote for an antiseptic in timber treatment.

Eventually more extensive use of creosoting came about, and rather sooner than had been expected, but the application was not in all cases in accordance with what had hitherto been considered standard practice, various schemes for saving medicine being proposed as substitutes for full treatment of creosote. Doubt was entertained as to whether any of these partial-dose methods would result satisfactorily. In fact one of the best authorities, if not the best acknowledged authority, on timber treating in this country, some eight or ten years ago, observing the tendency to adopt experimental methods which were being exploited under the name of "creosoting," in lieu of what was known to be good practice, predicted that disappointing results were bound to follow, and we are inclined to believe that his prophecies are coming true.

It was remarkable that many railway managements who were taking up timber treatment for the first time seemed to be under the impression that all timber-treating methods, so far as this country was concerned, were experimental, when, really, long-time records were available that would have shown the real worth of either the creosoting or zinc chloride methods had these records been sought and consulted. Undoubtedly some were misled by claims quite widely circulated at the time, to the effect that the records of any processes of treatment which had been practiced in this country by the railroads were too meager to prove anything as to the merits of the kinds of treatment that had been

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used. Hence it was supposed or, at any rate claimed, on the part of some, that timber treatment work in this country was something entirely new and essentially experimental, so that the logical thing to do was to try everything that was offered. At any rate much creosoting of the shell-deep, tar-mixed or other spurious kind has been carried on, and hardly any better results could be expected than is reported by the correspondent above quoted.

In France, where the creosoting of railroad ties is an old industry, heavy treatment has been the rule, forcing into the timber all of the creosote that it would take. In England, also, the creosoting of railroad ties is an old industry but, on the average, a somewhat smaller quantity of creosote per unit volume of timber has been used than was common practice in France. In comparisons of the practical results obtained in the two countries it has always been reported that the life obtained from creosoted ties in France was longer than in England, purely and simply because of the larger amount of material used per unit of the treated timber. If the long-standing results of experience in these countries have been correctly represented, and if any significance attaches to them, we fail to see the logic in much of the supposedly experimental work that has been done in this country. If the life of the timber depends upon the amount of preservative injected, as long-time experience seems to teach, then scrimping the material might be expected to result as scrimping usually does in other engineering work, no matter under what name or disguise the art is practiced.

(FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 9, 1912.)

DEPTH OF PENETRATION IN TIMBER TREATMENT.

Chicago, Nov. 5, 1912.

Editor Railway and Engineering Review:

The editorial on "The Shell Game in Timber Treatment," appearing in your issue of November 2, is a rather severe shot at some one, and causes the reader to wonder against whom it is aimed, the independent treating companies, the promoters of patented treating processes, or the railroads themselves.

Is it not a fact that the independent companies, doing contract work, are willing to inject into the timber all the antiseptic material that the railroads are willing to pay for? Is it not true that the patented processes are designed to give a fairly good degree of immunity at a low cost, and that the railroad companies are the beneficiaries of the reduction in price? Also is it not true that the principal reason for inadequate treatment is that the railroads will not stand for the expense of a thorough treatment?

Of course, if the treating companies do not furnish the quality or quantity of treatment called for in their contracts, or if they, or the

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promoters of the patented processes misrepresent the benefits to be derived from partial treatment, they are blamable and should be denounced, but if they make their representations in good faith and do their work honestly, the responsibility rests with the purchaser. If he expects something for nothing, or if he is willing to take a chance on the economy of a light treatment, knowing that he usually gets no more than he is willing to pay for, then the responsibility of success or failure is upon him.

Nor should the railroads be blamed thoughtlessly for their attitude. The conservation of tie life includes more factors than that of decay resistance alone. Ties depreciate from wear as well as decay, and while wear and decay are influenced one by the other, and the effects can not in practice be entirely differentiated, it is true that the highest economy can be realized only by an intelligent balancing of the means of guarding against these two destructive agencies.

While ties, treated to refusal, may be given a life of upwards of twenty years, measured in terms of decay only, there can certainly be no economy in expending the amount of money necessary to obtain such treatment if the mechanical life is limited to a much shorter period. This seems to be the condition which has prevailed in the past. The greatest economy is therefore secured by providing the best mechanical protection possible, and spending the smallest amount for treatment which will give a decay immunity equal to the mechanical life. We have thus three factors in the problem: the cost of mechanical protection, the cost of treatment and the cost of new ties.

If the average cost, in the track, of soft wood ties, untreated, is 60 cents, and the average life, untreated, is six years, it is obvious that no road would be warranted in spending more than 60 cents for mechanical protection and treatment to secure double the life. Otherwise it would be cheaper to buy a new tie.

The treatment to refusal of soft ties would give an average injection of not far from 16 pounds of oil per cubic foot, and the cost of this treatment would be not less than forty-five cents per tie. The best mechanical protection possible with present day devices (which will not give a life equal to the decay resistance obtained by this treatment) would cost at least 35 cents, a total of 80 cents per tie. It is, therefore, apparent that too much would be spent for treatment because the treatment and mechanical protection are not properly balanced, and because a new tie could be bought and put in the track for 60 cents. If a service of more than 16 years could be obtained by means of the above treatment and protection, then it would begin to show some economy. It is in the mechanical protection, however, that the limit is soonest reached.

With the quality of roadbed, and the wheel loads prevailing in this country no comparison as to tie life can justly be drawn between the United States and France. Over there they do not wear their ties out. We do, and therefore, before it is economically possible for us to give ties the maximum treatment, it will be necessary to provide against their mechanical destruction for a period equal to the decay immunity secured

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by such treatment. Mechanical protection should be the first to receive consideration, because upon it depends, to a great extent, the value of the chemical treatment. The important thing to be kept in mind is that only by increasing the mechanical life in a corresponding degree, can the chemical treatment be much increased with economy.

J. A. LOUNSBURY.

(EDITORIAL FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 9, 1912.)

DECAY AND MECHANICAL WEAR OF TIES.

A correspondent refers to our editorial of last week, in which we commented upon inefficient work in timber treatment, and he would like to know against whom these remarks were aimed—"the independent treating companies, the promoters of patent treating processes or the railroads themselves." Answering him in direct manner we may say that we have known all three of these interested parties to be accused of responsibility for scrimping the material in timber treating work. As to this it remains only to be said that if the poor work is chargeable to the wood preserving contractors or to the promoters of patented processes or patented solutions, the remedy is obvious; but if it is chargeable to the railroads themselves, as we believe it is in some instances that have been brought to our notice, then, very clearly, no one else is to blame, as our correspondent very truly observes. Thus far, there is really nothing to argue about, granting that the responsibility for the poor work can be definitely located.

A thing in our correspondent's letter that is of real interest to discuss is the point which he raises in reference to economy in the partial-dose method of treating railroad ties. He seems to uphold such practice, taking the ground that to inject into the timber all of the creosote that it will receive might preserve it so well against decay that it would outlive its usefulness! According to this view thoroughly treated ties will resist decay for a period longer than the "mechanical life" that is possible, the tie actually failing from wear before it has become decayed. His proposition is broadly enough stated, for he takes into account that wear and decay are to some extent interdependent, which view is correct, the wear of timber being accelerated as decay sets in, while the wearing of ties, as by rail cutting, undoubtedly promotes decay by making ready access for water to the interior fibers of the wood.

We are pleased that Mr. Lounsbury has brought up this question, for we think it a timely one. The idea is, indeed, to some extent current that it would not pay to practice full creosote treatment of railroad ties in this country, for not a few seem to think that the life of ties treated by the best and most thorough processes would depend

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more upon mechanical wear than upon decay of the timber. A railway official not long since told the writer that his company was treating its ties with a limited amount of creosote, the aim being to preserve the timber only as long as the tie could resist mechanical wear.

So much has been said about this matter of "mechanical wear" that we think it might be well to get a correct understanding as to just what the term is meant to convey. Does it mean rail cutting? or spike killing? or both of these and something more? In his reference to the subject our correspondent confines his remarks to soft wood ties. Now, as to this kind of timber, it must be conceded that under heavy traffic mechanical protection is necessary whether the ties are treated or not. It is no uncommon thing to find untreated pine ties or ties of other soft woods ruined by rail cutting before the wood has decayed. Applying, then, to such ties the principle of gaging the thoroughness of the treatment to suit the prospective durability of the ties under mechanical wear, very clearly there should be no treatment at all. Now, of course, rail cutting occurs at varying rates, according to the density of the traffic, magnitude of axle loads, excellence of rail surface, and perhaps other factors; and in some instances it might be so slow that unprotected ties will fail from decay sooner than from rail cutting. In such cases the question of preservative treatment is clearly worth considering; but, let us ask, who would think of putting a treated tie into the track where the conditions are such that rail cutting is bound to occur, without protecting it with tie plates? In fact, it is only a matter of common knowledge that, so far as soft wood ties are concerned, tie plates are required whether the ties are treated or not, and they have long been, and are still being, used by the million on untreated ties. Tie plates were a standard track device all over the country years before tie treatment was practiced to any considerable extent east of the Mississippi river. It is, therefore, foxy argument to combine cost of mechanical protection with cost of treatment, in arriving at the cost of treated ties in the track, and not to consider it at all, as does our correspondent, in stating the cost of untreated ties. He assumes the cost of untreated ties in the track at 60 cents; the cost of mechanical protection at 35 cents, and the cost of treatment, to refusal, at 45 cents. He then would have us believe that the cost of treated ties compares with the cost of untreated as 140 cents to 60 cents; when really, following the common practice of our railroads, the cost of mechanical protection should be included in both cases; and we then have the cost of the treated tie, mechanically protected, comparing with the cost of the untreated tie, also mechanically protected, as 140 cents to 95 cents. This is how the arithmetic of this question looks to the writer.

Again, if the rail cutting action is severe enough to affect the life of oak or other hard wood ties, independently of failure by decay, we take it that no competent engineer would hesitate to apply tie plates to such timber. In the case of treated oak, tie plates should certainly be used if there is liability of failure from rail cutting sooner than by decay; and, with such mechanical protection, whether the tie be soft wood or

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hard wood, we should think it would be the part of wisdom to treat the tie as thoroughly as possible, granting that tie plates can effectively protect it from rail cutting, and as to this we think there is hardly any question. Is it not true that in most cases where ties have failed from wear there has not been adequate protection against rail cutting, or that tie plates were not applied until after rail cutting had begun?

As to failure by spike killing, it is true that the life of ties, both treated and untreated, may be shortened by injudicious changing of the position of spikes when relaying rails, or in regaging, or in shimming, or perhaps some other kinds of track work where respiking is done; but such practice is independent of any question of tie treatment. We have many times called attention to this thing, and it does not necessarily follow that spike killing of ties is bound to result in the course of a more or less definite term of years, although it does occur from improper methods of work. It is bad practice when relaying rails to change the position of each spike to the opposite side of the tie face. The driving of a spike of any kind, or in any manner, into a tie, necessarily severs the fibers in a goodly portion of the width of the tie, and as often as this operation is repeated, in a direct line across the tie, by so much nearer is the tie at that point cut in twain. When relaying rails each spike, if practicable, should be redriven in the same hole or the same hole plugged, and where proper practice is observed in redriving spikes the destruction of the tie from this cause need not result. Neither is it to be overlooked that if ties were bored for the spikes, instead of driving the spikes into the solid timber, thereby crushing and displacing the fibers, the integrity of the timber in contact with the spikes could be longer maintained. In all treated ties boring for the spikes should certainly be practiced, the boring being done preferably before treatment, and, at all events, preservative material should be poured into the holes before the spikes are driven. So much for the mechanical wear of the ties from the spikes.

As to the question of the decay of the wood fiber surrounding the spikes before such occurs in the body of the tie, the conditions are all the worse the shallower the penetration of the treating solution. The spike must necessarily penetrate the interior of the tie, and if there be no preservative there, what is to prevent decay, especially where spikes have been pulled and the holes not carefully plugged?

In what other ways can ties fail through mechanical wear than in those stated? We have, to be sure, seen ties reduced in size to that of a fence post, nothing remaining but the heart of the timber, the tie having seemingly been pounded to pieces against the corners of particles of stone ballast, but in such cases careful investigation would show that the sap or exterior parts of the tie had softened from decay before such erosive action from the ballast had occurred. But, laying all the foregoing questions aside, who can state anything definte as to the "mechanical life" of ties, under such traffic conditions as exist in this country? We will grant, of course, as our correspondent points out, that ties in this country undergo greater pressures from train movements than is the case in France; but need there really be such a thing as destruction of ties from

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mechanical wear alone if proper attention be given to protection by tie plates and reasonable practice be followed in respect to the driving and redriving of the spikes? He concedes immunity from decay for upwards of twenty years for ties "treated to refusal." Is it impossible, by ordinary means, to realize in practical life of the tie this increased longevity of the wood itself?

Another thing to consider in this connection is the extreme variability in the penetration of the preservative where the ties are not treated "to refusal." If one thing is known better than some others in the timber treating business it is that segregation of pieces that are difficult of penetration, from those that take the treatment readily or at normal pressures, is impracticable; and this is true among timbers of the same species and having the same physical appearance. For this reason grouping of timber for treatment by sorting over sticks of the same species is rarely if ever attempted, and nothing can be accomplished if it were done. In practical work the refractory pieces get nothing more than a superficial staining from the preservative until after the easily penetrable timbers in the same cylinder are filled to the core. If then, the process is stopped at a limited absorption per unit volume of timber, or at what is known as "light treatment," a portion of the sticks or ties will have absorbed the bulk of the preservative and the refractory pieces will be penetrated but skin deep. There is only one safe method to pursue, and that is to work the pumps on the cylinders to the point of downright refusal of the timber to take in more of the solution, and even then some of the pieces will not be treated clear through.

In view of this fact, and if our correspondent's quotation of 45 cents (or thereabouts) for creosote treatment to refusal is correct, where is the logic in backing down at that figure when 34 or 35 cents per tie is a price commonly paid by our railroads for partial-dose treatment? Applying the two methods to a tie costing 60 cents in the track, the comparison is as $1.05 to 95 cents; and why take chances on such a vast difference in practical results as is possible, for such a small relative difference in cost?

After all that has been said let us inquire whether anyone in this country has tried creosoting of railroad ties to refusal; what kind of timber was treated? what does it cost? have the ties been properly protected from mechanical wear? how long will they last? and has it been demonstrated or can it be foreseen that such thorough treatment will not pay? If it will not pay, may not the zinc chloride treatment, which has been well tried out, yield results that are equal to those of creosoting half way done at double the cost of applying zinc chloride? Unless one has some such information and experience for guidance what is the use in trying to discourage trial of methods that are known to be in line with the best results possible?

Once upon a time a delegation visited a tribe of Indians, with the object of working some kind of a steal (no reflection upon the motives of our correspondent is here intended). After the Indians had given due consideration to the proposition, to see what might be in it for them, the chief of the tribe said to the spokesman of the delegation: "You are

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like unto a man standing on a bald butte, where there is no grass, talking to the wind.'' If there is nothing to offer against full-dose creosoting but bare assumptions, by all means let it be tried, to see what will come of it. If there is definite knowledge of results in the mechanical wear of ties that are afforded reasonable means of protection, it will be like grass under foot if persons who have such information will come out with it. We feel certain that a great deal of education along these lines is possible, and we invite readers to use these columns for such discussion of the matter as may be prompted from experience and observation.

(FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 16, 1912.)

LIFE OF TREATED PILING IN LOUISIANA.

November 12, 1912.

Editor Railway and Engineering Review:

Referring to the editorial entitled ''The Shell Game in Timber Treatment,'' published in your issue of November 2, and the letter of Mr. Lounsbury and editorial comment in the issue of November 9: The writer has had recent experience with treated piling in Louisiana, and he contributes the results of his observations with the hope that it may shed some light on the question.

An examination of 160 railroad trestles, of various types and length, on creosoted piling which had been driven from four to six years ago, showed some conditions which were astonishing to him. A very considerable percentage of the treated piles were of the short-leaf pine of that region. All the failures found were of this variety; no long-leaf pine had failed.

The percentage of defeetive piles in the structures was as follows: Driven four years ago, 13 per cent; driven five years ago, 9 per cent; driven six years ago, 18 per cent. The failures ranged from a state of decay which indicated that the pile would not last another year, to a condition where the decay was so complete that a prod could be pushed clear through the pile, once the shell was punctured. The decay was greater than that occurring in a good quality of untreated oak piles. Oak costs about 15 cents per foot, pine costs about 6 cents and treated pine about 30 cents.

An attempt to trace the cause leading to these failures developed the following information: At the plant where these piles were treated it is the custom to pile the untreated timber in open air, in piles up to 30 feet high. I saw no piles that high, but was told that sometimes they were so piled. The treating goes on at all seasons, and in all kinds of weather. There are times in Louisiana when the rainfall is so great that short-leaf pine lying in such piles would become so water logged as to make it doubtful if any treating solution could be injected into them.

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Following the matter further, a pile said to have been taken from the bottom of one of the piles and which had been out of treatment but a day, was bored into about eight feet from the large end. Water began to ooze out of the hole before the heart was reached. When the auger was withdrawn quite a little water flowed, and it continued to flow, in diminishing volume, for over half an hour.

At some bridges inspected a day or two after the test above mentioned, the piles for which had been driven about six weeks, it was found that enough creosote had dripped or oozed out of the piles to perceptibly stain the ground about the base of the pile.

These facts are stated for what they are worth. It may be well to add that the failing piles were all sound as to the sap part. The defective ones were detected by sounding with a hammer. It was found that the decaying ones would all give a hollow sound.

Referring to Mr. Lounsbury's letter: Assuming that an untreated tie would cost 40 cents and last six years on the average, that it cost 45 cents to treat to resistance, and that the endurance to wear of the tie were then but twelve years, would it not pay to do it? In this part of the country it costs to put ties into the track. Wages of trackmen are $1.35 per day, and the average per man is nine ties, in ballasted track; so that it costs 15 cents per tie to do this work. This cost should be added to the two-tie job, making it cost $1.10 (.40 + .40 + .30), where it will cost but one dollar (.40 + .45 + .15) with the treated tie.

ASSISTANT ENGINEER.

(EDITORIAL FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 16, 1912.)

SOME QUESTIONS IN TIE TREATING ECONOMICS.

The discussion in these columns of questions relating to tie and timber treatment, as it is actually worked in practice in this country, continues to bring out interesting opinion and experience. In this issue we publish a letter from an engineer who has recently encountered some remarkably faulty work in creosoted bridge piling, from which it would appear that the explanation for the shallow penetration of the antiseptic was the wet condition of the timber at the time of treatment. The objection to the treatment of timber in that way is, in effect, equivalent to that of treating unseasoned timber.

It is well that this information has been brought out, for timber storage at treating plants is usually, if not always, in the open air, and while the annual rainfall in Louisiana is known to be heavy, there are other parts of the country in which timber treatment is carried on where there are heavy rains occasionally, and sometimes, even, there are periods of long-continued rains. In view of the fact that artificial seasoning of timber by steaming and vacuum, previous to the injec-

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tion of the antiseptic, has been largely discontinued in this country, and that seasoning in dry kilns is not practiced at all, this matter of rain-soaked timber is one worthy of careful consideration. It is not to be presumed that a treating plant in full running would be closed down to await the air drying of timber after some days of wet weather, and, still, it can hardly be denied that a water-soaked tie or pile in a treating cylinder, without means for removing the water, comes within the classification commonly described as "refractory."

While the top layers of a pile of ties may be arranged to shed rain water, to some extent, nevertheless a hard or driving rain will penetrate a good many ties in the top and sides of the piles, making it possible for a considerable number of wet ties to find their way into the treating cylinders. If kiln drying or steaming and vacuum were practiced the rain water might not be so objectionable. The situation where ties had become rain-soaked and frozen, as is quite liable to happen in cold weather, has already been referred to in these discussions.

It is well enough to bear in mind, what is true in other industries besides that of timber treating, that commercial exigency is often antagonistic to the most efficient result in the product, and the question of artificial seasoning of timber, as well as the proper period to be allotted to air seasoning, might be considered in this light. In discussing this matter of air seasoning of ties piled in the yards of treating plants, a roadmaster recently said to us that, while it was the standard practice of his company to specify that the ties should be air seasoned at least nine months before treatment, in piles specially arranged to facilitate circulation of air about the ties, this rule was nevertheless frequently ignored and, to his knowledge, ties were often treated in less than a month from the time they were received green from the forest. In this he had reference to a plant owned and operated by the railroad which used the ties. He went on to explain that the tie supply was so irregular that it would be impracticable to air-season all of the ties the required length of time before treatment, without occasionally shutting down the plant for a considerable period, and, "of course," said he, "we would not think of doing that."

In regard to figuring the economy in treated ties, from first cost, cost of treatment, cost of laying in the track, etc., to which Mr. Lounsbury and our present correspondent refer, both of these gentlemen have failed to take into account a very important question which should not be overlooked in the economics of this subject, and that is the disturbance of the beds of the ties when renewing them, and the amount of surfacing and tamping which is required to bring the track to its original condition of support after tie renewals have been made, each year. There is nothing new about this point, for it is appreciated by many students of track maintenance, but frequently it seems to be overlooked by computers who are more familiar with the chemistry of antiseptics and the operation of treating plants than with the work of maintaining ties in the track. All that need be said

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is that when a tie is taken out of the track a good deal of its bed or foundation comes with it, and this bed is seldom, if ever, restored, to afford the new tie an adequate bearing, at the time the new tie is laid. In order to re-establish this condition of support, so that the new tie can do its full share of work in supporting the rail, a good deal of tamping must be done, at different times, and this costs money.

The practical effect of renewing ties in the track is a good deal like tearing up a well-constructed macadam pavement, as is frequently done in cities to lay water or gas pipes. In constructing such pavement there is much rolling and consolidation of materials, but once the foundation is disturbed a great deal of ramming and puddling must be done to prevent local settlement and ugly-looking street surface, so often in evidence after pavement has been cut through and undermined by the sewer or the gas diggers. Precisely the same principle applies in renewing ties. We have known of instances where the section forces labored hard to get the track into smooth surface early in the season. After the tie renewals had been made it seemed as though the previous work had been done for naught, all because the work of tie renewing had not been promptly and repeatedly followed up with the tamping bar.

(FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 23, 1912.)

THE SHELL GAME IN TIMBER TREATMENT.

Editor, Railway and Engineering Review:

In the issue of the Railway and Engineering Review for November 2, I notice an editorial article entitled, "The Shell Game in Timber Treatment." In this you are just a trifle unfair to the majority of wood preservers, in that you intimate that creosoting, as a rule, is poorly done.

The fact that the anonymous engineer found that some timber in his bridges had begun to decay so rapidly rather indicates that the engineer in question did not prepare specifications for treatment intelligently. The chances are that he specified about 12 pounds of creosote per cubic foot of timber and gave no consideration to the varying sizes to be treated. Any one with the slightest engineering ability could readily understand that the amount of creosote required to give a satisfactory penetration per surface inch in a 12x12-inch timber would not be sufficient in treating six 2x12-inch timbers, although the cubic contents remained unchanged. To illustrate this point:

A block of wood 12x12x12 inches has a surface area of 864 square inches. By dividing this block into six equal parts the surface area is increased to 2,304 square inches. If 12 pounds of creosote per cubic foot gave just barely enough penetration in the 12x12x12-inch block, would it be fair to assume that 12 pounds would be sufficient to give

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an equally good penetration in six 2x12x12-inch blocks? Treatment under such a system is often necessarily a "shell game." Until creosoting is put upon a sound basis through the adoption of "surface area" treatment, the "shell game" will persist as an ever-present evil.

A. B. C.

[We are not aware that in the editorial above referred to, or in any other discussion of timber treatment, we have intimated that creosoting, "as a rule, is poorly done." We have referred to some of the work of creosoting that had been poorly done, in different instances, but do not find that our remarks have assumed or intimated that even the larger part of creosoting work was of inferior quality.

The correspondent raises an interesting point over the difference between the use of a stated quantity of creosote per cubic unit of timber treated and depth of penetration per surface unit. A penetration of one inch in treating the six 2x12x12-inch plank, which he used for illustration, would impregnate the cubic foot of lumber through and through, while the same penetration of a 12x12x12-inch block would come far from through impregnation and require much less creosote; and yet the cubic volume of timber treated is the same in either case.—Ed.]

(FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 30, 1912.)

THE SHELL GAME IN TIMBER TREATMENT.

Editor, Railway and Engineering Review:

In your issue of November 23 Correspondent "A. B. C." takes some exception to the remarks from my letter which you quote. He is none too strong when he speaks of my ignorance on this subject. However, I can prove an alibi in this case, as I had nothing to do with the treating, or driving of these piles. However, as it may be of interest, I will say that some of the methods used may have had much to do with the failure of the work. These piles were commercially treated. The quantity of preservative used is not known to me. The piles were what is called "loblolly" pine. They were driven with a common hammer, used without a follower. They bruised badly under the hammer, and may not have been well driven. It was the custom, after sawing off the pile to "paint" the top and all parts which were cut in framing, with pure creosote oil. It is not for me to criticize the work. The men in charge are men for whom I have the greatest respect.

I do not know that this was good practice, but it was not such as has been the practice on work that I have been connected with. But if these men, capable and reliable, have made an error, is it not well that the result of such error be made known as widely as possible? I do not wish to pose as having wide knowledge. I do wish to learn. I have been enlightened by what others have written. A railroad 350 miles in length cannot have its own plant for this work. Its chief engineer may not be too positive as to what should be done, and the cheapness of some method claimed to be "just as good" may have weight with the president and the board. Will it enlighten them for "A. B. C." to accuse me of incom-

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petency? There is one clear fact. The creosoted piles under a ballasted-deck bridge, supposed to be a permanent structure, are failing. I asked the editor for some light, and from his personal letter, the literature he referred me to, and the later letters, I am getting some light.

Now, for another question: It has been suggested to me that we have a hole bored eight feet deep into the large end of each pile before treatment, and that later this hole be filled with oil and plugged. I would be glad of suggestions and criticisms on this.

Building a ballasted-deck bridge of treated piles and timber adds very largely to the cost. We should endeavor to get adequate life for the structure. ASSISTANT ENGINEER.

(FROM RAILWAY AND ENGINEERING REVIEW, DECEMBER 21, 1912.)

ESSENTIALS FOR EFFECTIVE WORK IN TIMBER TREATMENT.

Cleveland, Ohio, December 9, 1912.

Editor, Railway and Engineering Review:

The editorials and correspondence appearing in the five November issues of your paper are truly interesting and instructive. These discussions are certainly of the right kind to disseminate knowledge on a subject which, I regret to say, has been entirely too much wrapped in mystery and in secrecy, for the common good. I esteem the course you are pursuing in your endeavor to improve the methods of treating ties and timber, and I trust you will continue to bring out information for those who are conscientiously seeking it, and will not hesitate to strike a blow at poor creosoting work wherever done, no matter whether the stroke falls upon commercial preservers, or upon the railroad official who would authorize poor work done, or upon any one who in some way connives with practitioners who are doing poor work.

Examples of poor work, such as were reported to you by "Assistant Engineer," are not uncommon. I have seen railroad ties which were thoroughly saturated with creosote oil break to pieces when rolled off the cars, the interior being completely rotted. I have seen thousands of creosoted hardwood ties that had a penetration of less than ½-inch or only "shell deep." Any one who might be disposed to doubt this statement need only examine some of the creosoted ties distributed along the railroads that have them treated by the partial-dose processes, to be convinced of the truth of my statement. It will be noticed that in many instances, when some of the ties are adzed for rail bearing the creosoted wood is nearly all chopped away and the rail and tie plates rest upon untreated wood. Is there any one so blind and prejudiced as not to perceive that such creosoting work is bad policy? Is there not a remedy? Certainly there is. I will explain.

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The poor work can be attributed mainly to two causes, namely: (1) Ties, poles or timbers of any kind not being properly and sufficiently seasoned or dried before the injection of the preservative; and (2) the ties, piling or timbers of any kind being treated with only a limited quantity or partial dose of creosote oil.

In treating timber of any kind it is first necessary to extract the sap and water from the wood before the injection of the fluid. Water-logged or green timber, with its natural saps and its sap cells in their normal condition, will resist the introduction of any fluid, on the principle that two bodies cannot occupy the same space at the same time. To be able to introduce any solution the natural saps and water in the timber must be in some way removed. The absorption depends, in a very large degree, upon the dryness of the wood; the drier the wood the greater will be the absorption and dissemination, consequently the better the treatment.

The common practice at treating plants in this country is to stack the ties in open air for from three to twelve months, depending upon the kind and character of wood, climatic conditions, etc., until the moisture in the ties has evaporated sufficiently for reception of the preservatives. Piling and timbers are seasoned in a similar manner, but for a longer period. This is a very slow, crude and uncertain method. The seasoning is very unequal and erratic, some pieces retaining more moisture than others, and the impregnation is much influenced thereby.

Another method is to boil the timber in live steam, in the impregnating cylinders, just before the injection of the preservative, in order to force out the saps and water in the timber, by heating, loosening and expanding the same into vapor and breaking the cell walls to admit the introduction of the preservative fluid. This method is not altogether satisfactory, as the cells are full of vapor and water which resist the entrance of the preservative fluid. A fair penetration can be obtained by this process with zinc chloride—a water solution—but scarcely any with creosote oil. Several plants in Oregon and Washington employ the method of boiling the tie and timbers in creosote oil, which produces a similar effect on the wood as the boiling in live steam.

For thorough treatment, it is absolutely essential that all saps and water be removed from the wood, so far as possible, before the injection of the fluid, and this can be effected quickly and economically by means of steaming cylinders (separate from the impregnating cylinders) and drying ovens or kilns. The timber should be steamed as soon as possible after it is converted into ties, or piling, or dimension stock of any kind, so as to extract the sap and break the cell walls of the wood. After steaming, the material should be piled or stacked in the open air for seasoning. The evaporation of the vapor and water in the wood will be rapid and a much shorter period will be required to season the wood than when the preliminary steaming is omitted; and that will depend upon the character of the wood, climatic

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conditions and several other factors that influence the rate of evaporation. When sufficiently seasoned the material should be loaded on trams and introduced into the drying ovens where the drying can be completed in 12 to 36 hours, or an average of 24 hours. While the timber is hot, dry and in prime condition to receive the hot preservative it should be transferred from the ovens to the treating cylinders quickly, so as to lose as little of the heat in the wood as possible. The ties should be machined, that is, adzed and bored, just before they are placed in the ovens, and it is also advisable, before the treating is applied, to shape the timber to the form in which it is to remain.

When ties, piling and timbers are introduced into the impregnating cylinders, in a thoroughly dry and heated condition, and the hot preservative fluid is applied, the fluid is readily absorbed and the penetration is deeper and better diffused than when they are not thus prepared. The condition of the timber as regards moisture content is by far the most important of many factors influencing the absorption of the preservative, and unless this feature be given proper attention, the results from treatment will hardly ever be satisfactory.

The second requirement for good treatment is the injection of the preservative into the wood to total refusal, instead of in a specified quantity, such as six, eight, ten or twelve pounds of creosote oil, or six, eight, ten or twelve ounces of zinc chloride salt, per cubic foot of timber, as is frequently stated in specifications. The strength of zinc chloride solution should be specified, but not the quantity of salt per cubic foot. In all cases the preservative should be injected to refusal, regardless of whether creosote oil, zinc chloride, crude asphalt oil, or any other solution or mixture, is employed.

It is a common practice in treating ties or timbers with creosote oil to stop the operation or injection when the requirement as to quantity is met and before the receptivity of the timber is exhausted. This is manifestly wrong, and specifications which limit the quantity of oil or salt per cubic foot of timber are faulty. When the timber is waterlogged or green it is sometimes difficult, if not impossible, to inject even the minimum quantity thus specified. It is common to find specifications for creosoting piles or timber calling for an eight, ten, or twelve-pound treatment. In such specifications there is room for deception. I will explain.

In treating timber under pressure there is always a rebound of the fluid, when the fluid pressure in the cylinder is released. This rebound or "kick back," as some call it, varies with many conditions, such as character, density and moisture content of the timber, contraction of volume of creosote, expansion of the cylinder due to temperature, expansion of the wood, etc., and amounts sometimes to as high as 40 per cent. of the amount actually injected into the wood. It is estimated that out of a total specified injection of 10 pounds per cubic foot, or 35 pounds per tie, 8.7 pounds per tie may be forced into the cylinder, but either will not go into or not remain in the ties, thus

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constituting a total error of about 25 per cent.* Thus while the "recording gage" clearly indicates that a 10-pound treatment was applied, as specified in the contract, and for which the customer is supposed to pay, yet he actually gets only 7.5 pounds of oil per cubic foot in his timber. The "rebound" or "kick back," which always takes place when treating under pressure, and which, on an average, we estimate, amounts to nearly 25 per cent. of total injected in the timber, is what the "empty cell" creosote process workers allege to withdraw from the wood by means of an "initial pressure" or a "final vacuum." The physical laws of nature, however, operate the same for everybody and the "rebound" will occur, no matter whether that natural phenomenon is patented or not.

As you have properly stated, in one of your editorials, there is only one safe course to pursue, and that is to work the pumps to downright refusal of the timbers to take more of the solution, no matter whether the preservative is creosote oil, chloride of zinc, crude asphalt oil, chemicals or mixtures of any kind. Thorough impregnation is of first importance, and the quantity and cost of the preservative is of secondary importance. The quantity of preservative absorbed by the material is easy to determine, and the cost of the same can be definitely ascertained after the completion of the treating operation.

Shallow penetration has resulted mostly from the use of patented creosote processes. In order that the cost of treating ties and timbers by these processes, with creosote, would not exceed too much the cost of treating ties and timbers with zinc chloride, or asphalt crude oil, to refusal, the idea was conceived of injecting only a limited quantity of creosote oil into the wood; and it has been claimed that it was "just as good." The dose was fixed at 2 to 2½ gallons per tie, equivalent to five to seven pounds per cubic foot of timber. It is also represented that, by means of segregating the timbers into groups, according to species, density, moisture content, etc., no less than 95 per cent of the ties will receive "uniform and thorough" treatment. This claim has been absolutely disproved by the experiments at Shirley, Indiana, and Toledo, Ohio, which were published in your paper, August 3, 1912. It was found that the variation in absorption was very large, some ties getting but very little oil, while some received considerably more than the average quantity.

The partial-dose advocates advance another reason for not treating ties to refusal. According to their theory and assumptions, to inject into the timber all the creosote oil it will receive might preserve it so well against decay that it would "outlive its usefulness." You have so ably and so thoroughly discussed this question that there is little or nothing for me to say. The balancing of "mechanical life" with the "chemical treatment life" is a favorite argument with these partial-dose advocates, and when all of their theories are proven wrong or impractical and there is nothing more to offer in support of their claims, they advance that

*Authority, Forest Service Bulletin 118, U. S. Dept. Agriculture, November, 1912, Page 33.

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vague argument. They talk learnedly about "mechanical life," "mechanical abrasion," "mechanical wear," and repeat these technically-sounding terms as though they had, by common acceptance, an established meaning. Truly, I am glad you have extended an invitation to readers to tell us something definite about the "mechanical life" of ties. This question admits of answers that would be about as definite as it would be possible to give to such ones as "How long is a stick?" "How tall is a tree?" "What is the ratio between the length of a stick and the height of a tree?" Furthermore, were it possible to determine the mechanical life of ties with any degree of accuracy, expressed in years, under all traffic conditions and for all kinds of woods, can any one tell us what the "chemical life" of ties would be, expressed in years, treated with various preservatives and in different quantities?

Before we can do any intelligent "balancing" we should know something definite about both sides of the equation. The next time any speaker or writer presents this "mechanical life" argument we trust he will confer the favor of stating specifically the ground upon which he bases his assumptions, and not be "like unto the man on a bald butte, talking to the wind."

Decay and mechanical wear are so interwoven and interdependent that it is manifestly impossible to determine the ratio of these two destructive elements. The destruction is due to their combined action and cannot be separated.

In conclusion, I give the following summary and recommendations:

1. Ties, piling and timbers should be thoroughly seasoned or dried by artificial process, consisting of steaming, open air drying and oven or kiln drying.

2. Ties, piling and timbers should be treated to refusal, with whatever preservative the user or customer demands.

If these recommendations are followed the number of complaints of poor work and malpractice will diminish, and the "shell game in timber treatment" will not be so much in evidence.

W. F. GOLTRA.

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APR 22 1915
FORESTRY DEPARTMENT

Some Facts

About

Treating Railroad Ties

Parts IV, V, VI

By
W. F. GOLTRA
PRESIDENT, THE W. F. GOLTRA TIE COMPANY

CLEVELAND, OHIO
1913

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PREFACE TO PARTS IV, V and VI.

In the following pages the author presents a discussion of wood preservation in Europe and America and a list of wood preserving plants in North America. The greater part of this material was prepared for the American Wood Preservers' Association and has been printed in the Proceedings for the year 1913.

There was considerable objection to the printing of the author's discussion of Mr. Weiss' paper by some members of the Association. These men argued that the statements, which were made in rebuttal of Mr. Weiss' argument, might have ill effect upon the timber-treating industry as a whole and do injury to the Association; but, in fact, it was a subtle trick, which has been successfully worked before, to hide their infirmities and deficiencies. After careful consideration, the Executive Committee concluded that the remarks were admissable and authorized the printing of same in the proceedings.

Many problems in the art of treating wood with antiseptics have yet to be solved and there is undoubtedly much room for improvement. Many years of experience, exhaustive study and close observations of the methods employed in timber treating, both in this and foreign countries, persuade the author that the greatest improvements in the present methods employed lie in the direction of a speedier and more efficient method of seasoning the timber, a more thorough preparation of the timber for receiving the injection of the antiseptic and a greater economy in the handling of the material in process of treatment, by means of modern equipment and appliances.

A majority of the timber-treating plants, both in America and Europe, are treating ties and timbers by the same methods and in the same manner as was practiced a half a century or more ago. This consists of simply placing the timber to be treated in air-tight cylinders and submerging the wood in a preservative fluid and then forcing more liquid into the wood by means of force pumps. Some modifications of this primitive method have been tried and recommended and some improvement has been accomplished, but it has been slow, because in a majority of cases the experimenters and practitioners confined themselves closely to the method invented by Sir William Burnet and Mr. John Bethell, of England, in 1838, and any departure from these two established methods was made with diffidence.

Development and improvement in the timber-treating industry has, therefore, been comparatively slow. It has hardly kept pace with that in several other industries of similar character, and there are reasons for this. Aside from diffidence in adopting new methods, there have been, and there are now prevailing, baneful influences which tend to hinder and retard the development and im-

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provement in this important industry, but with the acquisition of a better understanding of the fundamental and underlying principles governing timber treating, these will eventually disappear.

There are some honest people in the wood-preserving industry, there are some of them that do good work and a lot of them that mean to do good work, but there are in this business, as in any other, people who are not doing honest work. It is a curious fact that in all ages, mountebanks have posed as masters and teachers. The world is full of the story of the impostor, the false teacher and the bogus reformer. The timber-treating industry has not escaped the wiles of the fakir and the impostor.

Unscientific and unscrupulous "shell gamesters," peddling worthless processes, have infested the field. By means of "long term" contracts with some of our railroads, **awarded without competition,** several of these treating companies are enjoying special privileges. As the late Samuel Rowe once remarked, "The fakir must have his day, but it will be a short day, and when it ends not only will he get his deserts, but those who he misled, innocently on their part, will have cause to mourn." The author still pledges his best efforts and will not hesitate to interpose when dishonest practices prevail and when the simple incentive is the "money there is in it."

It should be borne in mind that some of these people, who are so industrious and vigilant in suppressing information and knowledge regarding the principles of timber treating, in order to keep the uninitiated ignorant of the facts, have ulterior motives. There is danger that their trade will fall into disrepute. In this they are not unlike certain idolatrous Athenians of old, mentioned in the Holy Scriptures. St. Paul said to them, "We ought not to think that the God-head is like unto gold, or silver, or stone graven by art and man's device." This kind of preaching caused no small stir in that community of idolaters, for a certain man named Demetrius, a silversmith, who made silver shrines of Diana, that brought no little business unto the craftsmen, whom he gathered together with the workmen of like occupation, said, "Sirs, ye know that by this business we have our wealth. And ye see and hear that not alone at Ephesus, but almost throughout Asia, this Paul hath persuaded and turned away many people, saying that they be no gods which are made with hands, and not only is there danger that this our trade come into disrepute, but also that the temple of the great Goddess Diana be made of no account and that she should even be deposed from her magnificence, whom all Asia and the world worshippeth."

And when they heard they were moved with wrath and cried out, "Great is Diana of the Ephesians." There was great confusion in the assembly. The mob laid hold of two of Paul's followers and was about to make away with them when the town clerk

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quieted the crowd by saying: "Ye ought to be quiet and do nothing rashly. Ye have brought hither these men which are neither robbers of churches nor blasphemers of your Goddess. Wherefore, if Demetrius and his craftsmen which are with him have a matter against any man, the law is open and there are deputies; let them implead one another. There is no cause for riot." And thus having spoken he dismissed the assembly.

The exponents, exploiters and defenders of bogus treating processes and some dealers in certain preservatives that are not what they are represented to be, have in many ways attempted to suppress and conceal all facts that would shed any light on their questionable methods. Such revelations would operate against their private interests. Their attitude is well expressed in the words of the Hoosier poet, "They seen their duty and they did their damdest, angels could do no more." But in spite of their opposition and machinations, the people are awakening to a realization of the true state of affairs.

As with the idols of the Athenians, the people will in due time realize the frauds and impositions upon their credulity and abolish these antiquated processes. Some of the writer's opponents are fearful that what he says might upset or depose some of the old idols in timber treating and do injury to the cause. There is no need for worry in that respect. The timber-treating industry, like the Christian religion, is established on a firm and enduring foundation and has a honest and needful purpose; and it will continue to grow and bestow its beneficence upon mankind, regardless of what anyone can do or say. In due time most of the imposters, grafters and "shell gamesters," like the idolaters, will be converted and gradually "fall in line" with the procession which makes for progress and honest business methods.

Special privileges and private favors stifle competition and thereby a favored few are enabled to corner the business. This naturally retards and hinders the development of the industry. Cutting out these cancers of privilege would excite competition in efficiency and permit the development of more modern methods. It would serve, not the greedy special interests, but instead the general welfare.

The ideal of American democracy is **equal opportunity for all, special privileges for none**. Quoting President Wilson in his first message to Congress, "We should abolish everything that bears even the semblance of privilege or of any kind of artificial advantage, and put ourselves under the stimulation of a constant necessity to be efficient, economical and enterprising, masters of competitive supremacy, better workers than any in the world."

THE AUTHOR.

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PART IV

Comparison of Zinc Chloride and Creosote for Preserving Cross-Ties

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A COMPARISON OF ZINC CHLORIDE WITH COAL-TAR CREOSOTE FOR PRESERVING CROSS-TIES.

By Howard F. Weiss.

Although a great many preservatives have been tested to preserve cross-ties, zinc chloride and coal-tar creosote are now by far the ones most extensively used in the United States. The author has frequently been called upon to compare these two preservatives; in fact, the number of such requests has been so large that it has led to an examination of the merits and deficiencies of each preservative. This paper aims to present the information which has thus been collected and to invite discussion. Please, note, however, that only cross-ties are considered, and the data which follow should not be confused with poles, piling or other products.

According to statistics gathered by the Federal Government, the number of cross-ties treated with zinc chloride in the United States shows no increase in the past four years, while the number treated with creosote has increased rapidly. (See Table 1.)

Table 1.—Number of Ties Treated With Zinc Chloride and Creosote in the United States.

Preservative.	Year.				
	1907	1908	1909	1910	1911
Zinc chloride ..	9,864,765	8,640,230	8,051,054	9,195,861	9,445,961
Creosote	5,750,874	9,620,420	9,943,360	14,841,843	16,510,721

This in itself might be looked upon as an answer to the query: "Which is the better of the two?" But after a careful investigation it appears that this question can not be so easily dismissed. I asked twelve leading operators of wood-preserving plants their opinions why the number of ties Burnettized in this country did not increase. Their replies group themselves as follows:

(1) Poor workmanship in Burnettizing, either through ignorance or otherwise.
(2) The zinc leached from the ties, or the railroads fear that it would.
(3) The salesmen of coal-tar creosote are more industrious than the zinc salesmen.
(4) Zinc-treated ties cause trouble with the automatic signal apparatus.
(5) The empty-cell creosote processes reduced the initial cost of treating with creosote.
(6) Railroads consider creosote cheaper in the long run, and because ties are growing scarcer they want to give them the treatment which make them last the longest.
(7) Railroad engineers have concluded that zinc chloride has a tendency to corrode spikes.

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(8) Tie treatment is now largely east of the Mississippi, where the climate is moist, while Burnettizing began west of the Mississippi, where the climate is dry.

(9) Heavier tie-plates are now being used, warranting a more permanent preservative treatment.

These replies are very instructive and certainly worth careful thought.

The factors which I have considered in comparing the two preservatives under discussion may be grouped as follows:

(1) The toxicity of the preservative—namely, its ability to prevent decay.
(2) The ability of the preservative to penetrate the tie.
(3) The permanency of the preservative in the tie.
(4) The effect of the preservative on the strength of the tie.
(5) The effect of the preservative on the corrosion of spikes and plates, and the operation of block signals.
(6) The financial saving due to the use of the preservative.

Of somewhat lesser importance are:

(7) The uniformity in composition of the preservative and ease of securing it.
(8) The combustibility of the preservative.
(9) The ease of handling the preservative and ties treated with it.
(10) The ease with which the penetration of the preservative can be determined.

Toxicity of the Preservative.

Zinc chloride relies upon its toxic properties solely to protect ties from decay. Creosote, in addition to this, has a more or less waterproofing effect, which also acts as a protection against decay. According to the toxic tests made by Malenkovic, zinc chloride offered about twice the resistance to fungous attack (penicillium) as coal-tar creosote free from phenol. Tests made at the Forest Products Laboratory showed that ordinary coal-tar creosote had about the same toxicity as zinc chloride, four-tenths per cent being sufficient in each case to prevent fungous growth (Fomes annosus).*

The Ability of the Preservative to Penetrate Wood During Treatment.

In the author's opinion, this is a feature of tie preservation which is given, in practice, too little consideration. All toxicity data show that both zinc chloride and coal-tar creosote are powerful fungicides, and that small quantities of them will inhibit decay. It is good practice, therefore, to diffuse the preservatives thoroughly through the tie so that as many of the wood cells as possible will be poisoned. A tie might contain ten or twelve pounds of creosote

*These tests were made by the Petri dish method, in which the culture medium was made of juice from 1 pound of beef, 25 grams of Lofflunds malt extract, 20 grams of agar agar and 1,000 cc of distilled water. A 1 per cent solution was figured as 1 gram of preservative in 100 cc of culture medium.

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per cubic foot and yet be poorly treated if the oil is not well diffused; in fact, not nearly as well preserved as a tie having only four or five pounds of the oil per cubic foot, but with the oil uniformly and deeply distributed.

It is well known that water solutions will penetrate wood more easily and thoroughly than oils; for example, in making what are called the "penetrance tests" at the Forest Products Labratory it took about three minutes to force zinc chloride solutions through 6 inches of hemlock parallel to the grain, while creosote took over 30 minutes. Again, under simliar conditions in treating red oak and maple ties we forced about 50 per cent more by volume of zinc chloride solution into them than we did coal-tar creosote. Any process which aims to impregnate ties with only a certain amount of preservative irrespective of the penetration secured is, in the author's opinion, operated on an incorrect basis; and any specification which will enable ties to be treated in this manner is a poor specification. In treatments with zinc chloride I believe a strong preliminary vacuum should be drawn, and the solution admitted to the cylinder without breaking the vacuum, after which pressure should be applied and held to "refusal." The absorption of dry salt can then be controlled by varying the concentration of the solution rather than by varying the amount of solution forced into the ties. Unfortunately, this simple treatment can not be used with creosote (except with certain resistant ties) because too much oil would be absorbed and the treatment would become too expensive.

The Permanency of the Preservative in the Tie.

Permanency, as applied to preservation, involves two phenomena: (a) volatilization; (b) leaching.

Zinc chloride under conditions of use is non-volatile. Creosote, on the other hand, evaporates from the tie. The rate at which it evaporates depends on many conditions, such as its composition, method of injection, atmospheric conditions during seasoning, etc. The following examples are given to illustrate such evaporation:

(1) Some North Carolina pine poles creosoted according to the American Telephone and Telegraph Company's Specification No. 367, and set in 1897, were removed about nine years afterward and the oil in them examined. About 57.1 per cent of the original oil in the top and about 37.5 per cent in the butt of the pole was lost almost exclusively through evaporation during this period.*a*

(2) Ties creosoted by the Rueping process in Texas and

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a Von Schrenk, Fulks and Kammerer. Proceedings A. R. E. and M. of W. Association, Volume 9, page 738.

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piled to air season lost from May 12 to October 28 from 40 to 60 per cent. of the creosote injected. Ties treated by the straight creosote process lost in the same time 20 per cent.*b*

(3) Red oak ties treated by the full-cell process lost in 200 days (November, 1910, to June, 1911,) about 19 per cent of the weight of preservative injected. When similar ties were treated by an "empty cell" process the loss in the same period was about 52.7 per cent. Maple ties treated by the full-cell process lost in 105 days (March to June, 1911,) 13.4 per cent of the weight of creosote injected. When similar ties were treated by an "empty cell" process they lost in the same time 23 per cent. As these ties were all air-seasoned and at approximately the same moisture content, little of this loss can be attributed to evaporation of water*a*

This objection to creosote has led in some cases to mixing it with tar, the idea being that such a mixture will hold in the tie the more volatile constituents of the oil. It is quite probable that tar will do this, but there are strong objections to such practice, and it is the author's opinion that its adoption should take place only after much more convincing data than we now have been obtained.

Creosote is practically insoluble in water, while zinc chloride is readily soluble. The solubility of zinc chloride may be illustrated by the following examples:

(1) Twelve Burnettized lodgepole pine ties were sawed in two. One-half of each tie was placed in the water for 24 hours, at the end of which period the amount of salt leached out was determined and the half ties allowed to dry for 24 hours, when they were again submerged. This was continued for several days. The second half of each tie seasoned until air dry was then ultimately submerged and dried just as the first ties had been and the amount of salt leached out determined. The results are given in Table 2.*c* If the ties contained originally .5 pound of dry zinc chloride per cubic foot the per cent of loss for the freshly-treated ties at the end of the sixth period would be 40 per cent and for the seasoned ties 32 per cent.

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b Report by A. M. Steinmayer to E. O. Faulkner, dated October, 1905.

a Forest Service Bulletin 123, by F. M. Bond. Moisture percent of red oak ties treated by full-cell process at time of treatment equaled 45, and by the "empty cell" process 45.7. Moisture per cent of maple ties treated by the full-cell process at time of treatment equaled 32.4, and by the "empty cell" process 31.1. These ties were treated as follows:

Full Cell Process.—Ties run into cylinder and submerged in creosote at 170° to 190° F. under a maximum pressure of 175 pounds per square inch until an absorption of approximately 12 pounds per cubic foot was obtained. Oil then run from cylinder and a final vacuum of 26 inches held for 30 minutes to dry ties, after which they were removed from the retort.

Empty Cell Process.—Ties run into cylinder and air pressure applied (50 pounds per square inch for red oak; 90 pounds per square inch for maple) for at least ten minutes. Creosote then pumped into cylinder at 170° to 190° F. against this pressure, releasing excess of air but maintaining pressure. When the cylinder was filled with oil the pressure was raised (140 pounds per square inch for maple, 175 pounds per square inch for red oak) and held to refusal (viz: until the measuring tank gauge showed no further absorption in two successive readings of 15 minutes interval), after which the cylinder was drained of oil and a 26-inch vacuum held for 30 minutes, when the ties were removed.

c Bulletin 41, Bureau of Forestry, Herman von Schrenk, page 15.

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Table 2.—Amount of Zinc Chloride Leached from Treated Lodgepole Pine Ties.

	Amount zinc chloride (grams leached out during)						
	First Period	Second Period	Third Period	Fourth Period	Fifth Period	Sixth Period	Total
Freshly treated ties.	585	318	306	226	205	201	1841
Seasoned ties.....	677	352	154	109	122	62	1476

(2) Small pieces of hemlock impregnated with about .5 pound of dry zinc chloride per cubic foot were soaked without subsequent air seasoning in distilled water for 30 days and the water analyzed. In the first five days about 46 per cent. of the salt had leached out, and in 30 days about 62 per cent. This, however, was an exceedingly severe test.*a*

(3) Forty-eight ties of Douglas fir and lodgepole pine injected with one-half pound of dry zinc chloride per cubic foot were submerged in water for 24 hours and dried about 7 days, an analysis being made, and the ties again submerged. This was repeated about forty times, covering a period of over 300 days. During the first 70 days approximately 18 per cent of the original amount was lost, and at the end of 300 days the total loss was 25.5 per cent *b*

From tests made in the Forest Products Laboratory it appears that certain amounts of zinc chloride can not be leached out of wood even by very severe soaking. Just how much of the zinc chloride thus remains is not known to the author, but tests on this point are now under way at the laboratory. It is claimed that the leaching of zinc chloride in ties can be retarded by air-seasoning them after treatment, or by coating them with an oil. I have no conclusive data on either of these claims.

Effect of the Preservative on the Strength of the Tie.

With decay largely eliminated from properly preserved ties, and with the tonnage of our roads constantly increasing, the problem of prolonging the life of ties from rail and spike cutting is becoming more and more acute. Obviously, a preservative which will decrease the strength of ties when injected will be subject to serious criticim. Tests made by the Forest Service some six years ago on loblolly pine ties indicate that the presence of zinc chloride did not weaken the wood under static loading, but tended to make it brittle under impact, while no decrease in strength was noted for ties treated with creosote.*c* Tests made since then indicate that both preservatives weaken the wood, although, if *properly injected,* the weakening thus caused is too small to be of practical importance. In one case a decrease of 40 per cent in the bending strength of wood creosoted by a commercial plant was, however, observed.

a Volume 13, page 279, Eighth International Congress of Applied Chemistry, Howard F. Weiss.
b Proceedings New York Railroad Club, Feb. 18, 1910, F. J. Angier.
c Circular 39, Forest Service, by W. K. Hatt.

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The Effect of the Preservative on Corrosion of Spikes and Plates and the Operation of Block Signals.

Some pieces of flange steel of equal dimensions, weight and quality were immersed, respectively, in coal-tar creosote and a 6 per cent solution of zinc chloride for three weeks and constantly heated at 98° Centigrade. At the end of this time the steel in the creosote lost .0064 gram, while that in zinc chloride solution lost 1.4636 grams. Of course this was a very severe test, not comparable to what takes place in the track; but even at atmospheric temperatures the corrosion of steel spikes and plates in contact with zinc-treated ties is probably greater than with creosoted ties. Whether it is of sufficient intensity to be a real detriment is not known to the author. The concensus of opinion among those who claim experience seems to be that if the zinc ties are properly seasoned before placement in the track the corrosion is of no appreciable consequence.

The presence of zinc chloride in wood is very liable to decrease the resistance of the tie to the passage of an electric current; consequently, if the flow of current is away from the track a marked corrosion of the spikes will occur. This action may, however, take place in untreated ties, especially when wet. Zinc chloride, being deliquescent, tends to keep the ties moist, while creosote tends to waterproof them; hence deterioration of spikes subject to the passage of electric currents is more likely to take place in ties treated with zinc chloride than in those treated with creosote.

The electrolytic action of zinc chloride and creosote in ties is a subject about which much discussion has occurred, particularly in connection with the operation of automatic block signals. The most accurate tests known to me, bearing on this subject, were made by Mr. J. T. Butterfield, of Purdue University, in 1910. His tests concluded that ties treated with creosote offer greater resistance than those treated with zinc chloride, and less resistance than untreated ties, as follows:

Effect of Treatments Upon the Electrical Resistance of Ties.

Kind of Wood.	How Treated.	Ratio of resistance (treated to natural).
Loblolly pine.....	Full cell process....	0.34
Shortleaf pine.....	Full cell process....	0.79
Red oak	Burnett process....	0.16

The experiences of several signal engineers are that zinc-treated ties will cause trouble with the block signals if they are placed in the track unseasoned, or if the distance between blocks is too long. A shortening of the circuit to about 1,000 or 1,200 feet has, in many instances, remedied these difficulties.

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Financial Saving Due to the Use of the Preservatives.

A discussion of all factors finally simmers down to a discussion of cost. Because of the scarcity of authentic service records generalities must still be used. The numerous test tracks now placed throughout the country will, it is hoped, furnish us with accurate data upon which to base decisions. Quoting from a report of the Wood Preservation Committee of the American Railway Engineering Association:

> "Creosoting at present can not be relied upon to preserve ties more than 15½ to 19 years, an absolute maximum, unless the ties are protected against mechanical deterioration. If badly injected they perish from decay in five to twelve years. Burnettizing, when well done, can be relied upon to preserve ties from ten to fourteen years. There are great differences in the thoroughness with which the work can be done."*

From the records quoted below we will assume that a tie properly treated with zinc chloride will last, on an average, 12 years, and with creosote 17 years, which, in an untreated condition, would last 5 years. We will assume that the cost of the tie untreated is 45 cents, the cost of creosoting 30 cents, the cost of Burnettizing 15 cents, and of placement in the track 15 cents. We then have:

Cost of untreated tie in track, 60 cents.
Cost of Burnettized tie in track, 75 cents.
Cost of creosoted tie in track, 90 cents.
Life of untreated tie in track, 5 years.
Life of Burnettized tie in track, 12 years.
Life of creosoted tie in track, 17 years.

From these values, figured at 5 per cent compound interest, we find that:

Annual cost of an untreated tie equals 13.86 cents.
Annual cost of a Burnettized tie equals 8.40 cents.
Annual cost of a creosoted tie equals 8.01 cents.

And if figured without interest:

Annual cost of an untreated tie equals 12 cents.
Annual cost of a Burnettized tie equals 6.25 cents.
Annual cost of a creosoted tie equals 5.29 cents.

From which it may be deduced that both preservatives are very economical to use in comparison with untreated ties, and of the two, creosote is ultimately slightly cheaper. Under the assumptions here taken zinc-treated ties must last about 12½ years in order to have the same annual charge as creosoted ties, while the creosoted ties must last 15½ years in order to have the same annual charge as the zinc-treated ties. The author leaves the reader to manipulate these figures in any way he sees fit, but in so doing calls attention to the records given in Table 3.

Uniformity in the Composition of the Preservative and Ease of Securing It.

The zinc chloride produced in the United States is, for a com-

*Volume 10, Part I, Proceedings A. R. E. and M. of W. Association, 1909.

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Table 3—Reported Life

Species.	Laid By.	Treatment.
Beech	German Imperial Railways	Creosote
"	Germany—Union Railways	"
"	Germany, Union Railways	"
"	France—Nord Railway	"
"	Germany—Hanover Railway	Zinc chloride
"	Germany—Brunswick Railways	" "
"	Switzerland—Swiss Nord Ost Bahn	" "
"	Germany—National Railways	" "
"	Germany—Imperial Railways	" "
"	Prussia—All State Railways	Rutgers
Cedar	C. and N. W.	Wellhouse
Fir	German and Austrian Railways	Creosote
"	German and Austrian Railways	Zinc chloride
"	Switzerland—Swiss Nord Ost Bahn	" "
" (Douglas)	Southern Pacific	" "
Hemlock	N. Y., N. H. & H.	Creosote
"	Pittsburg, Ft. Wayne and Chicago	Wellhouse
" and tamarack	C. R. I. & P.	"
Oak	France—Southern Railway	Creosote
"	France—Western Railway	"
"	France—Orleans Railway	"
"	France—Paris, L. & Med.	"
"	France—General	"
"	France—State Railways	"
"	Germany—Union Railways	"
"	Germany—Union Railways	"
"	Germany—Union Railways	Zinc chloride
"	Switzerland—Swiss Nord Ost Bahn	" "
" (White)	Average from reports, 22 roads	Untreated
" (White)	C., B. & Q.	"
Pine	German Railways	Zinc chloride
"	France—Southern Railways.	Copper sulphate
"	German Union Railways	Creosote
"	German Union Railways	"
"	France—General	"
"	France—Orleans Railway	"
"	Germany—Altona-Kiel Railway	Zinc chloride
"	France—State Railways	" creosote
" (Mountain)	Union Pacific	Wellhouse
" (White)	N. Y., N. H. & H.	Tilhamy
Redwood (Baltic)	Russia—St. Petersburg	Zinc chloride
" "	Great Britain—Belfast and N. C. Ry.	Creosote
" "	Great Britain—Furness Railway	"
" "	Great Britain—Great Eastern Railway	"
" "	Great Britain—Gt. Northern Railway	"
" "	Great Britain—London, Tilbury and Southend Railway	"
" "	Great Britain—London & N. W. Ry.	"
" "	Great Britain—London & S. W. Ry.	"
" "	Great Britain—Manchester S. & L. Ry.	"
" "	Great Britain—Taff Vale Ry.	"
Tamarack	Pittsburg, Ft. Wayne & Chicago Ry.	Wellhouse

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of Ties in Service.

Average Life Years	Source of Information.
19.5	Railway Gazette, Vol. 32, 1900, p. 23.
30.0	Proceedings Nat. Elec. Light Ass'n., 1910, p. 336; also Trans. A. S. C. E.—1899, p. 304.
34.0	Proceedings Nat. Elec. Light Ass'n., 1910, p. 336.
27.0	Proc. Pac. Ry. Club, March 18, 1905, p. 276.
14.8	Trans. A. S. C. E., 1885, p. 317.
13.0	Trans. A. S. C. E., 1885, p. 317.
10.0	Trans A. S. C. E., 1899, p. 349.
9.0	Trans. A. S. C. E., 1899, p. 304, also N. E. L A., 1910, p. 336.
21.0	Railway Gazette, 1900, Vol. 32, p. 23.
12-16	Preservation of Timber, by S. M. Rowe, p. 295, 1907 Ed.
15.0	Am. Ry. Eng. and M. of W. Ass'n., Proc., 1907, p. 470.
14-16	Trans. A. S. C. E., 1885, p. 318.
14-16	Trans. A. S. C. E., 1885, p. 318.
12-14	Trans. A. S. C. E., 1899, p. 349.
10.91	Report sent to F. S. by E. E. Calvin, So. Pac., 1912.
20.0	Proc. Am. Ry. Eng. & M. of W. Ass'n., 1912, Vol. 13, p. 872.
10.71	Railway Gazette, 1905, Vol. 38, p. 282.
10.57	Railway Gazette, 1905, Vol. 34, p. 202.
10-15	Trans. A. S. C. E., 1901, p. 503.
15-20	Trans. A. S. C. E., 1901, p. 503.
15.0	Trans. A. S. C. E., 1901, p. 503.
12.0	Trans. A. S. C. E., 1901, p. 503.
25.0	Am. Ry. Eng. & M. of W. Ass'n., Bul. 118—p. 85-93.
25-30	Railway Gazette, 1901, Vol. 33, p. 164.
24.0	Nat. Elec. Light Ass'n., Proc., 1910—p. 336, also Trans. A. S. C. E., 1899, p. 304.
28.0	Nat. Elec. Light Ass'n., Proc., 1910—p. 336.
15.0	Nat. Elec. Light Ass'n., Proc., 1910—p. 336, also Trans. A. S. C. E., 1899, p. 304.
20-25	Trans. A. S. C. E., 1899, p. 349.
8.25	Proc. Wood Preservers' Ass'n., 1911, p. 123.
10.0	Proc. Wood Preservers' Ass'n., 1911, p. 123.
12.0	Trans. A. S. C. E., 1899, p. 304, also N. E. L. A., 1910—p. 336.
8-10	Trans. A. S. C. E., 1901—p. 503.
20.0	Nat. Elec. Light Ass'n., 1910, p. 336, also Trans. A. S. C. E., 1899, p. 304.
23.0	Nat. Elec. Light Ass'n., 1910, p. 336.
20.0	Am. Ry. Eng. & M. of W. Ass'n., Bul. 118, p. 85-93.
13-16	Trans. A. S. C. E., 1885—p. 317.
6.6	Trans. A. S. C. E., 1901, p. 503.
10-15	Trans. A. S. C. E., 1901—p. 503.
9.0	Trans A. S. C. E., 1899—p. 311.
14.0	Proc. Am. RY. Eng. & M. of W. Ass'n., Vol. 13, 1912, p. 872.
8.0	Railway Gazette, 1901, Vol. 33, p. 164.
15.0	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
15.0	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
12-15	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
12.0	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
25-30	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
16-20	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
12.0	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
16.0	Trans. A. S. C. E., 1901, Vol 45, p. 501.
15.0	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
8.84	Railway Gazette, Vol. 38, 1905, p. 282.

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mercial product, extremely uniform in its composition and the quality can be readily duplicated and obtained. Creosote, on the other hand, varies considerably in its composition, and is not easily secured in satisfactory grades. The American Railway Engineering Association recently drew up three specifications for creosote to be used in tie preservation, and more discussion and argument has taken place over what kind of an oil should be used than has taken place over any other feature of wood preservation.

It is the author's opinion, however, that these conditions are changing for the better and that the future looks bright.

The Combustibility of the Preservative.

Zinc chloride is non-inflammable; creosote is inflammable; hence a zinc chloride plant presents a lower fire risk than a creosote plant. Zinc chloride-treated ties can be considered more fire resistant than untreated ties. When freshly treated creosoted ties are easily ignited, but their resistance to inflammability increases as their seasoning progresses. Inflammability tests gave a temperature of ignition for zinc-treated wood of 287° C., 19 per cent of the wood, by weight, being burned. Freshly creosoted wood tested under the same conditions ignited at 176° C., and 40 per cent of its weight was burned. When, however, it was air-seasoned after treatment for 90 days the temperature of ignition was 216° C., and the loss in weight 27 per cent.

Ease of Handling the Preservative and Ties Treated With It.

Zinc chloride solutions can be readily handled at much lower temperatures than coar-tar creosote and do not present the many difficulties of heating that accompany the operation of creosote plants; on the other hand, they cause a great plant depreciation, due to their corrosive action. Several cases have come to my attention where trouble was experienced in getting track men to handle creosoted ties, supposedly on account of their disagreeable nature and their effect on the health of the track men. Such objections can, however, be avoided. I have heard of no complaints against zinc-treated ties in this connection.

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Inflammabilty of Treated Hemlock.*

How treated	Temperature of ignition °C. Days after treatment.		Loss in weight due to burning calculated in % of of weight before ignition. Days seasoned		Character of combustion
	2	90	2	90	
Untreated	320	———	29	———	Burned freely.
Full cell process	176	216	40	27	Burned freely, black smoke, easily extinguished.
Burnett process	———	287	———	19	Hard to ignite, burned poorly, easily extinguished.

Ease With Which the Preservative can Be Tested and Analyzed in the Tie.

The presence of creosote in the ties can be detected more readily than the presence of zinc chloride; and, inasmuch as a knowledge of the depth of penetration is highly important, creosoted ties are much easier to examine. A chemical analysis of the treated ties is not feasible for daily use, so that the best method of detecting the depth of penetration in zinc-treated ties is to cut a section and apply chemicals to produce color changes, or to heat the freshly-cut section in an oven above the boiling point of water.* However, a careful inspection of the treating plant and process is worth as much, if not more, than a critical examination of a few ties.

Summary of Results.

All the factors discussed above are summarized in Table 4. Its study will show that there are good grounds for hesitating in the selection of a preservative to be used in treating ties, and that the conditions peculiar to each road, or even parts of the same road, should affect such a decision. No sweeping generality can have much practical significance. The more noteworthy points brought out by this study are at present:

(1) Zinc chloride and coal-tar creosote, when used under normal conditions, are both effective preservatives of cross-ties, and there is little choice between them so far as annual charges are concerned.

(2) Creosoted ties in general cost initially more than Burnettized ties, the cost of treatment being from about 2 to 3 times as great.

*Tests to determine the Commercial Value of Wood Preservatives, by Howard F. Weiss, Volume 13, page 279, Eighth International Congress of Applied Chemistry.

*Forest Service Circular 190, by Ernest Bateman, and American Wood Preservers' Association Proceedings, 1912, page 187.

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(3) Creosoted ties last, on an average, longer in the track than Burnettized ties, hence require less frequent renewals and changes in the roadbed.

"I might say there is one phase I did not emphasize in this paper, and that is this: It is getting more and more difficult to acquire a satisfactory supply of hard wood for manufacture into cross ties. Therefore, it would appear that companies should handle their ties so that they will secure from them the greatest maximum life, thus necessitating the purchasing of a fewer number of ties. That point is not brought out in this paper. It is an important point from a practical standpoint."

(4) If creosote advances appreciably in price it will very probably result in stimulating the number of ties treated with zinc chloride.

"These are the four general conclusions that I have drawn as a result of this study, and I assure the association that I would be very glad, indeed, to have any additional data that bears on this problem and to have the discussion just as full as you might wish to make it.

Table 4.—Synopsis of the Comparison of Zinc Chloride With Coal-Tar Creosote for Preserving Ties.

Factors Considered	Zinc Chloride.	Coal-tar Creosote.
Toxicity	Toxic limit about .4 per cent.	About same as for zinc chloride
Volatility of Preservative in tie	Nonvolatile	Volatile
Leachability of preservative	Leaches from wood	Does not leach from wood
Penetrance of preservative	Penetrates easier than creosote	More resistant than zinc chloride
Effect on strength of ties	Produces but little weakening	Weakening of no practical importance
Corrosion of metal	More corrosive than creosote	Corrosive action insignificant
Effect as an electrolyte	Favors current leakage	Much more resistant than zinc chloride
Uniformity of composition	Very uniform	Very variable
Cumbustibility of treated wood	More resistant than untreated wood	Much more combustible than zinc-treated wood
Ease of handling	Easier than creosote	More difficult than zinc chloride
Ease of testing penetration	More difficult than creosote	Simple
Financial saving due to use	Slightly less than for creosote	Slightly more than for zinc chloride
Cost of treatment	Lower initial cost than creosote (About 15c. per tie.)	Higher initial cost than zinc chloride (About 30c. per tie)
Ultimate life	Shorter than creosote (About 12 years)	Longer than zinc chloride (About 17 years)

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THE PRESIDENT: May we have the pleasure of hearing from Mr. Goltra on this same subject.

Discussion of Mr. Weiss' Paper by Mr. Goltra.

MR. W. F. GOLTRA: This is a well-written paper and deserves very careful reading and consideration. I have very carefully considered Mr. Weiss' paper and desire to make a few remarks.

The successful treating of ties depends on two general factors, namely: (1) Method of seasoning, preparation for service in track and mode of injection of the preservative into the wood; (2) kind and quantity of preservative used. The relative importance of these two factors are in the order named. Many preservatives have been tried and recommended, but only a few have been chosen and the long list has practically narrowed down to the following preservatives:

1. Chloride of Zinc.
2. Coal Tar Oil and Petroleum Tar Oil (Creosote).
3. Crude Oil.

The first two are used in much larger quantities than crude oil. Crude oil has not been used very extensively for treatment of cross ties in this country, but this is not because it is inferior to either of the first two named, but on account of another reason which I will mention later on.

Referring to Mr. Weiss' table No. 1, he gives the number of ties treated with zinc chloride and creosote oil during the years 1907 to 1911 inclusive, but he omits to include such ties as were treated with a combination of zinc chloride and creosote oil; also omits those treated with crude oil; therefore his statement is apt to be a little misleading in comparing the number of ties treated with the various preservatives.

From an examination of the records, I find that during this period the number of ties treated with the mixture of zinc chloride and creosote and crude oil is as follows: 1907, 4,240,000; 1908, 5,515,000; 1909, 4,039,000; 1910; 6,506,000, and 1911, 5,184,000.

As the percentage of the mixture was approximately twenty per cent. creosote oil and eighty per cent. zinc chloride solution, it would seem proper to divide these quantities between these two ingredients on the same basis, after deducting the number of ties treated with crude oil, to arrive at a more nearly correct comparison of the use of these two preservatives. For example, in the year 1911, of the 5,184,000 ties, approximately 1,000,000 were treated with crude oil and the remainder with the mirture, so that twenty per cent. of 4,000,000 or 800,000 should be credited to creosote oil treatment, and the eighty per cent. or 3,200,000 should be credited to zinc chloride treatment. That is the way it looks to me. We should not ignore the treatment of such a large proportion of the ties, because they are treated with a mixture or with crude oil, otherwise we are apt to draw wrong conclusions. But even if these modifications were made to his statement, it would afford but little criterion to go by to determine which is the best wood preservative. The fact that the use of creosote oil in treatment of railroad ties

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in this country has increased more rapidly than the use of zinc chloride, is no proof that the former is better than the latter. Mr. Weiss gives nine replies received from operators of wood preserving plants, giving their opinions why the number of ties treated with zinc chloride did not increase. For the most part, these reasons are vague and non-essential. The third quotation which he mentions, that "The salesmen of coal tar creosote are more industrious than the zinc salesmen," comes the nearest the mark of any. (Applause.) The most essential reason for the great increase of creosote oil over zinc chloride is not stated by Mr. Weiss. This reason which I am about to state outweighs tenfold the nine that are specified.

It is a well-known fact that prior to the year 1905, practically all of the crossties treated in this country were treated with chloride of zinc singly or in combination with other ingredients, such as tannin, glue and creosote oil. At that time exploiters of patented creosote processes, otherwise called "empty cell" processes, appeared in the timber-treating industry. They represented that much economy could be effected by treating ties with a partial dose of creosote oil; that by means of an initial air pressure or a final vacuum, or both, the ties could be completely saturated and a large proportion of oil injected into the wood could be recovered. These exponents succeeded in making several railway managements believe it. One large system, The Atchison, Topeka & Santa Fe Railway, that had used zinc chloride treatment successfully for more than twenty years, adopted one of these untried processes, and rebuilt one of their plants at a great expense to employ this new method—the Rueping process. Other roads followed their example, and this process was adopted by the Chicago, Rock Island and Pacific; Missouri, Kansas and Texas, and the Illinois Central Railroad. In all, about 5,000,000 ties are treated annually by this process. In 1904, Mr. C. B. Lowry, of Lexington, Ky., obtained a contract from the Cleveland, Cincinnati, Chicago and St. Louis Railway Company to treat 550,000 ties per annum with creosote oil, for a period of ten years. He organized a commercial company and built a plant at Shirley, Ind., which was subsequently merged into the American Creosoting Company. A couple of years later Mr. Lowry obtained a patent "for withdrawing surplus oil by means of the application of a final vacuum." (*See Foot Note.*) Contracts similar to that made with the Cleveland, Cincinnati, Chicago and St. Louis Railway were as follows:

This process had been practiced in Europe and America for more than 40 years when Mr. Lowry obtained his patent. The operation is employed in nearly every treating plant in this country, at the present time, for the purpose of hastening of the drying of ties before withdrawal from the cylinder. This process is described in Mr. Weiss' paper as "Full Cell Process," but the patentees call it an "Empty Cell Process." (Author.)

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Road.	Location.	Year Built.	Treated.
Chg., Indpls. & Lvle. Ry.,	Bloomington, Ind.....	1905	250,000
Rock Island-Frisco Lines,	Kansas City, Mo.....	1907	750,000
Rock Island-Frisco Lines,	Springfield, Mo.....	1907	750,000
Rock Island-Frisco Lines,	Hugo, Okla.....	1907	750,000
Rock Island-Frisco Lines,	Marion, Ills.....	1907	750,000
L. S. & M. S. & M. C. R. R,	Toledo, O.....	1909	1,200,000
Delaware, Lack. & Western,	Patterson, N. J.....	1909	500,000
Lehigh Valley Ry.,	Bound Brook, N. J.....	1909	400,000
Kansas City Southern Railway, International & Gr. Northern, Texas & Pacific Railway,	Shreveport, La.....	1910	750,000
N. Y. C. & H. R. R. R.,	Rome, N. Y.....	1911	750,000
New Orleans Gr. Northern Ry.,	Bogalusa, La.....	1912	200,000

The above, including the C., C. C. & St. L. Ry's contract makes a total of 7,600,000 ties, and is the minimum quantity to be treated annually by the Lowry process, during the life of these contracts.

All of these contracts were for terms of ten or twenty years, and specify that the ties shall be treated by the "Lowry" process, using an average of two and one-half gallons of coal tar creosote oil per tie.

By virtue of the adoption of these so-called "empty-cell" processes by certain railroads, and by virtue of the long term contracts made by other railroads for treatment of their ties by independent treating companies, which in both instances required the use of creosote oil exclusively, such preservatives as zinc chloride, crude oil or other antiseptics having any merit were excluded and were put beyond consideration. There was no choice left in the matter of selecting the most efficient and economical preservative, and in this way competition was stifled.

During the year 1905, I estimate that approximately fifteen million ties were treated, of which about ten per cent., or 1,500,000 ties, were treated with cresote oil and 13,500,000 with zinc chloride. The quantity of ties treated with creosote oil gradually increased until 16,510,000 ties were treated with this preservative in 1911. Of this quantity I estimate that approximately thirteen million were treated by the so-called "empty cell" processes, injecting only a partial dose of creosote oil into the ties. The adoption of these processes by various railroads absolutely precluded the use of anything else but creosote oil; therefore, is it any wonder that there has been such an increase in the number of ties treated with that preservative? Those were the chief causes, and they outweigh all others tenfold, in explaining why the number of ties treated with zinc chloride in this country did not increase more during the past seven years.

The same reason explains why such a comparatively small number of ties were treated with crude oil. If this preservative was offered by dealers to any railroad company or the treating company, treating ties

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by these "empty cell" processes, they were usually informed that under their contracts they were restricted to the use of creosote oil, and no matter how meritorious their product might be, it could not be used. Now heavy crude oil or petroleum is a good preservative. It has been used from time immemorial for preserving wood from decay and to protect it from insects. In Burmah there are upwards of 100 pits or wells, with a general depth of 210 to 240 feet, the shafts of which are square forms and lined with horiontal balks or timbers. The oil which is extracted in buckets splashes on the timbers and saturates them with oil. In this way the timbers in these shafts have been protected from decay for centuries. Numerous cases of this character have been seen in this country. There are long stretches of oil soaked track in the oil regions of Pennsylvania that should get the full benefit of its preserving qualities, but no data is available. It appears with the success met with on the Gulf, Colorado & Santa Fe Railroad in using crude oil petrolium for protecting railroad ties from decay that this oil may be of great value in wood preservation. A test was started in 1902, and the ties treated with Bakersfield oil, to the extent of 23 to 82 pounds of oil per tie. Most of these ties are still in good state of preservation. The Atchison, Topeka & Santa Fe Railroad is now operating a treating plant at Albuquerque, New Mexico, using this material, and it is said they are getting good results. Some ties treated with petrolium and laid in the tracks of the Central Railroad of New Jersey, near Bound Brook, New Jersey, remained in the track protected from decay for twenty-six years.

Someone asks, "Why is not heavy crude oil as good as creosote oil for treating railroad ties?" I reply that it is. "But," my friend asks, "must not the preservative be poisonous?" To this I answer, "no, not necessarily." Right here I want to ask our Association to warn men not to subscribe to the doctrine of some chemists touching the hypostatical principal, that a preservative must possess a toxical or poisonous property to be effective, until they have examined it a little. There are substances which prevent decay that are not in the ordinary sense considered poisonous and crude oil or petroleum tar oil are some of them. Much of the development in the line of timber treating has been on the supposition that the wood must be impregnated with a germicide—a substance that tends to destroy animal and vegetable life; but we find substances that are not germicides that do preserve wood and it is presumable that this element is not absolutely essential, although it may play a part in the preservation of wood. It would seem that any antiseptic that would resist or correct putrefaction in the wood, will prevent decay, although it may not be germicidal or of poisonous character, and if wood is rendered unfit by an antiseptic or protected by a germicide or both, it will not decay. An antiseptic may be substances which will inhibit the growth of

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fungi, while germicides are understood to be substances which are active poisons to these growths. Thus coal tar creosote is strongly antiseptic and germicidal. Water gas or petroleum tar creosote is antiseptic and probably germicidal. Wood creosote has strong antiseptic properties, while petroleum or heavy crude oil is probably not germicidal, but it is antiseptic.

About the middle of the last century when creosoote oil was beginning to be used to some appreciable extent in Europe, the specifications called for at least ten per cent. of tar acid. which is chiefly carbolic acid and is a virulent poison. At that time it was generally supposed that the acid was the chief element of the preservative, but gradually the oil specifications reduced the requirement until it was eliminated altogether from the specifications Some authorities pointed out that carbolic acid was solvent in water and evaporated quickly and therefore afforded little or no protection to the wood. Whether or not these conclusions were correct I do not pretend to know, but suffice to say that the idea that the preservatives to be efficacious must be of a poisonous or germicidal character underwent considerable change.

Incidently I desire to state that creosote oil distilled from petroleum tar contains no carbolic acid and yet it is a good preservative and used in very large quantities in this country. I do not suppose that many of you know that about one-half of the "creosote" oil manufactured in this country is made from petroleum tar and the other half is made from coal tar. Specifications for "creosote" usually say that the oil shall be obtained from coal tar, but, nevertheless, one-half of it is obtained from petroleum tar. Two-thirds of the gas used for illuminating purposes in the United States at the present time, is water-gas, made from petroleum and about 80,000,000 gallons of tar are made as a by-product of its manufacture. On account of the well-known preservative value of coal tar creosote and its relatively higher cost, oils of other origin are generally looked upon as adulterants, and while the preservative value of the coal tar creosote may not have been lessened by the admixture, the practice constitutes a fraud if the material is sold as straight **coal tar creosote.** In Bulletin No. 78 of the Forest Service the following statement is made:

"Petroleum tar creosote is already used in large quantities, most of it being sold not under its own name, but as an adulterant of coal tar creosote. It contains some of the most important constituents of coal-tar creosote, as well as those of the paraffin series. Its analysis by fractional distillation is sometimes identical with that of the coal-tar product, and it is probable that after injection into the timber it would show no more rapid volatilization."

Specifications for creosote oil, should be revised and include oil obtained from the distillation of petroleum tar and wood tar as well as from coal tar, and avoid further deception on that score. And finally. if petroleum tar oil is a good preservative, why are not the heavier fractions of crude oil or petroleum good preservatives? The latter

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possesses all the chemical elements of the former, which is derived from them.

As Mr. Weiss very correctly observes, a discussion of all factors entering into the question of treating railroad ties finally simmers down to a discussion of cost. In order to make a comparison of the relative economy of treated ties by various methods and with different chemicals it is necessary to determine, at least to one's own satisfaction, these two factors, namely, (1) cost of treated ties laid in the track; (2) average life of the ties. Given these two factors, the first expressed in dollars and cents and the latter in terms of years, the relative economy of the two can easily be calculated.

Mr. Weiss gives a hypothetical case and assumes that ties "properly" treated with zinc chloride will last an average of twelve years and with creosote, seventeen years, and that the cost of treating is fifteen cents and thirty cents, respectively. He also assumes the cost of an untreated tie is forty-five cents and laying in the track fifteen cents in both instances, which, of course, is correct. These factors are assumed for the purpose of reasoning and deducing proof, and Mr. Weiss quotes some statistics of ties in service and leaves the reader to manipulate these figures in any way he sees fit.

I have taken the trouble to critically examine some of the records given in his Table 3, and find a good many of them of doubtful value to predicate the average life of the ties treated with creosote oil and zinc chloride. For example, the record of ties laid by the Union of German Railways was taken from the proceedings of the National Electric Light Association and those proceedings do not give the authority for the table published in their proceedings.

Before attempting to deduce any idea from this table presented by Mr. Weiss, as to the average life of ties, treated with either preservative, one should critically examine the authenticity and also consider the method or process by which the ties were treated. In referring to these alleged records of the Union of German Railways, Mr. Weiss failed to state that the beech ties and pine ties treated with creosote absorbed 66 to 79 pounds of oil per tie. Now Mr. Weiss would lead us to believe that the life of ties treated with creosote oil in this country, for thirty cents, into which only an average of two and one-half gallons, or 22 pounds of creosote oil is injected would be an average of seventeen years. My opinion is that such ties will have an average life of ten years if treated with an average dose of 22 pounds per tie; or twelve years if treated to refusal, say forty pounds per tie. If treated with zinc chloride to refusal, eleven years. It is understood that the ties are seasoned in open air in the usual way and are not protected by tie-plates. I have given this subject of average life of treated ties

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much study and I present herewith a chart (CUT) showing the estimated life of treated ties, treated with creosote oil and zinc chloride, either singly or in combination, by different methods of preparation and treatment. The best practical illustration of the progress of decay will be the facts as they occur. The year in which the ties are put in the track is the starting point; the year in which the first tie fails is another step and the rate from then on is the curve of failure; and the year in which the last ties are removed is the culmination. If every tie were exactly alike in texture, density or soundness, all should fail at once, but this is never so. The curves in the diagram illustrate graphically how treated ties would be removed from the track, when their average life is from eight to sixteen years. The tables show the percentages and tie years for each curve. These curves of failure and tables of percentages can be used to determine closely the length of service railroad companies are getting out of the treated ties now in their tracks without waiting many years. By comparing the removal with the number of ties treated in any one year it will show which curve of failure it is following, and give the probable mean life of the tie, which is the essential thing to know.

In making comparisons with European records to determine the probable average life of treated ties treated in this country, we must not overlook the methods employed for treatment. The conditions must be alike in all cases, otherwise the comparison is unfair. Mr. Weiss quotes cases where it is said ties have an average life of as much as thirty-four years and it is currently reported that in France creosote ties have been known to last thirty years. It should be borne in mind that this is not the mean or average life and cannot possibly be, for if one will undertake to trace a line on this chart for ties having an average life of thirty years, he will find that some of the ties would have to last as long as fifty-eight years. We admit that ties treated in Europe, particularly by French railways, have a much longer average life than those treated in America, for the simple reason that the work is done more thoroughly. I figure the average life of oak and beech ties treated in France, with creosote oil, to refusal (that means forty or fifty pounds on an average per tie), adzed and bored and warmed in ovens prior to impregnation, as near as I can judge from available data, to be fifteen years. I take it Mr. Weiss estimates the average life at seventeen years. Perhaps the mean between these two estimates is about correct, namely, sixteen years.

Referring again to Mr. Weiss' table, he gives some data for the French State Railway, published in the Railway Age Gazette in 1901. The ties referred to were samples at the Paris Exposition in 1900 and therefore are not representative of the average life of ties obtained by the French State Railway. We would not be surprised to find on exhibition at the Panama-Pacific Exposition, to

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be held in San Francisco in 1915, and to which we have received an invitation, samples of cross ties, treated with zinc chloride, in this country, that have been in service for thirty years or more. It would not be difficult to collect a number of such ties, but that would not prove anything conclusive.

Again, we would not be surprised to find on exhibition samples of timbers from oil wells, which have been preserved from decay by petroleum for more than fifty years.

Returning to Mr. Weiss' hypothetical case and substituting my estimate of life of ties treated with creosote at a cost of thirty cents each, we have,

Cost of creosoted tie laid in track.....	.90	
Average life.....	10 years	
Annual charge.....		.1107
Cost of zinc treated ties laid in track.....	.75	
Average life.....	11 years	
Annual charge.....		.0855
Difference		.0252

Thus the creosoted ties cost 2½ cents per tie per year more than the zinc treated tie. Multiplying this by the average number of years, which in this case is 10½ years, makes a difference of 26½ cents per tie in favor of the zinc treated tie. My estimate of the average life of ties treated with an average quantity of 2½ gallons of oil per tie, with ordinary air seaasoning, and no tie-plate protection, at ten years, is made advisedly. Unfortunately no records are kept by any of the railroads, so far as I know, treating ties with a partial dose of creosote oil, of the performance or life of ties, but from personal observations of renewals and inquiries made of road masters, and section men, I find that the percentages of renewals in most cases followed closely the ten-year curve of failure shown on this chart, which would mean they would have an average life of ten years.

In view of the foregoing, I desire to offer the following conclusions:

(1) Zinc chloride and coal tar, petroleum tar and wood tar creosote, when used under normal conditions, are effective preservatives of cross ties, and the first named is more economical so far as annual charges are concerned.

(2) The average life of ties depend upon their method of preparation and treatment, and the quantity of antiseptic injected into the wood. Ties treated with either preservative will give good service if properly treated.

(3) Heavy crude oil is a good wood preservative and equally as effective as creosote oil or zinc chloride. The cost per gallon

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is about one-half that of creosote oil in certain parts of the country.

Finally, my friends, I trust you will not think that I am exploiting or advertising any particular preservative. I sincerely aim to be fair and unprejudiced and my motive in presenting the foregoing facts to this Association is that any preservative proposed shall be carefully and fairly considered to the end that those preservatives shall be used which effect the greatest economy in treating ties and timbers. I thank you. (Applause.)

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PART V

History of Wood Preservation

by

W. F. Goltra.

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HISTORY OF WOOD PRESERVATION.

By W. F. Goltra.

In order to write a history on wood preservation the historian must necessarily refer to the records left by many writers. The literature dealing with this subject is voluminous and bewildering, and the writer can only attempt to give in this paper a summary of the historical development of the industry and make brief mention of numerous processes and methods that have been tried and recommended for the preservation of wood. Discussion of the efficiency, practicability and merits of individual processes would, obviously, be beyond the limit of this paper. Numerous processes have been employed for the purpose of preventing the decay of wood from dampness, atmospheric action, or the destructive operation of animals and parisitic plants. The principle in nearly all has been the same, namely, the injection into the vessels of the wood of some material which, by combining with the albumen of the woody tissues, prevents the decomposition or gives it a poisonous character. Some processes advocated consisted simply in external appplication of preservatives to the wood. The trials were attended with varying degrees of success, and of the large number advocated (Paulet mentions 174 in all) only a few have survived. Of these processes many of them would, no doubt, prove effective, provided they could be carefully and economically applied, but most of them have not survived, either through cost of material, difficulties in their operation or their inefficiency.

Very little is known of preservative processes adopted in ancient times. Pliny observes that the ancients used garlic boiled in vinegar with considerable success, especially with reference to preserving timber from attacks by worms; he also states that oil of cedar will protect such timber annointed with it from worm and rottenness. Oil of cedar was used by the ancient Egyptians for preserving their mummies. Tar and linseed oil were also recommended.

The idea of preserving wood by the action of oil is, therefore, by no means new, as we find that the ancients used vegetable, animal and mineral oils for the preservation of wood used for various purposes. The petroleum oil wells near Prome, in Burmah, have been used from time immemorial. Wood for shipbuilding and house building was invariably saturated or coated with a product of those wells, and it is stated that the results were entire immunity from decay and the ravages of the white ants. Many other substances have been employed for the preservation of timber, which will be referred to later.

The oldest of all artificial processes for the preservation of timber, and one used among most savage tribes, is charring the surface of wood that is to be inserted in the ground.

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Very little is known of any preservative process previous to the year 1657. In that year Johann Glauber, the famous chemist of Carlstadt, Germany, experimented with vegetable pyroligeous acid, the wood having been first carbonized by the action of fire, then covered with a coating of tar and immersed in the acid. (Pyroligneous acid is obtained by the distillation of wood. It is an acetic acid, holding in solution oily impurities.) Since this period many processes have been tried. In order to convey some idea of the numerous experiments the writer presents herewith a list of the different processes proposed for the preservation of wood from the year of 1657 to 1846, prepared by Mr. J. A. Stoeckhardt and published in the "Artizan," London, England, April, 1848:

From this compilation it will be observed that nearly every substance under the sun, from vapor of eupion to a mixture of tar and decoction of tobacco leaves were used for the preservation of wood.

In 1737 Mr. Emmerson patented a process of saturating timber with boiled oil mixed with poisonous substances; but this process was very little used. This, we believe, was the **first** patent on wood preserving.

About 1740 Mr. Reid proposed to arrest decay by means of a certain vegetable acid (probably pyroligneous acid). The method of using it was by simple immersion.

In 1756 Dr. Hales recommended that planks at the water-line of ships should be soaked in linseed oil to prevent the injury to which wood is subjected when alternately exposed to wet and dry; and, indeed, many ships were built in which a hollow place was cut in one end of each beam or stern-post which might constantly be filled with oil. Sometimes the tops of the ship masts were hollowed in the form of cups or basins and holes bored from the end to a considerable way down the masts and oil was poured into these cups and it was left to find its way down the capillary vessels to the interior of the timber.

Before the earliest of these dates, however, the preservative properties of solution of slack-lime and chloride of sodium, or common salts, were facts of common knowledge. The former was extensively used throughout Britain for timber for estate work. Fence timber treated with this solution often lasted upwards of 20 years; the imbibition was by immersion in open tanks.

At the beginning of the Eighteenth Century a member of the Royal Academy of Stockholm called attention to the use of **alum** for preserving wood from fire, stating that wood or timber for the purpose of building may be secured against the action of fire by letting it remain for some time in water wherein vitriol, alum or any other salt has been dissolved which contains no inflammable parts. In 1815 Mr. Wade found that alum was not a good preservative and caused speedy decay of timber. In the same year

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No.	Date.	Discoverer.	Preparation Employed.	Mode of Application.
1	1657	Glauber	Vegetable tar and pyroligneous acid.	The wood having been carbonized by the action of fire, is covered with a coating of tar and immersed in pyroligneous acid.
2	1740	?		Exposing the wood to the action of vapor.
3	1798	Volmeister.	Solution of sea water.	Washing and immersion.
4	1806	Perkins.	Ditto.	The interstices of the wood filled with dry salt.
5	1815	Bowden.	Salt water.	Repeated immersion of the wood in the sea.
6	1820	Pasley.	Undecomposable liquids, such, for instance, as the acids.	The wood is first boiled in water, and then the concentrated liquids applied.
7	1821	Knowles & Davy	Chloride of Mercury.	Immersion.
8	1821	Dimsdale.	Vegetable tar, from which the pyroligneous acid had previously been extracted.	Repeated Immersions.
9	1822	Prechtl.	Vapor of tar.	The wood is first exposed to the vapor of water alone, and afterwards to that of a mixture of water and tar.
10	1823	Oxford.	Oil of tar, previously treated with gaseous chlorine.	Repeated coatings.
11	1824	Cox.	Mixture of fish oil, rosin and sulphur.	Saturated by coating the wood and rubbing.
12	1825	Langton.		Extraction by a vacuum of the air from heated wood.
13	1826	Newmarch.	Mixture of linseed oil, sulphate of iron, verdigris, arsenic and alum.	Boiling the wood in the mixture for three hours.
14	1828	Gossier.	Saline solutions, forming mutual decompositions, and leaving in the wood an insoluble combination: for instance, (a) Chloride of calcium; (b) Glauber salts, sulphate of iron, arseniate of soda.	Alternate immersions in solutions of the various salts.

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No.	Date.	Discoverer.	Preparation Employed.	Mode of Application.
15	1829	Carey.	Mixture of salt, powdered charcoal, and animal or vegetable oil.	The wood having been perforated at different points, the mixture is introduced and the hole closed.
16	1831	Breant.	Oily and resinous matters, or solutions of appropriate salts.	The wood is impregnated by pressure in a vertical cylinder, in the natural state, or after having exhausted the air and the sap. The exhaustion is performed by means of another large cylinder communicating with the first, and into which the steam passes, which is condensed by an injection of cold water, and which answers the purpose of an air pump.
17	1832	?	Smoke.	The wood is exposed for a long time to the smoke of green wood, burning slowly.
18	1832	Kyan.	Solution of chloride of mercury.	Immersion, and afterwards by pressure.
19	1832	? and since Chevalier, 1836.	Tar and decoction of tobacco leaves.	Immersion or coating.
20	1833	?	Solution of rosin in fish oil.	Coating and repeated rubbing.
21	1833	?	Solution of india rubber in fatty oils.	Idem.
22	1834	Strutzke & Soc. of Arts, Berlin.	Solution of sulphate of iron.	Repeated coatings, or introduction of wood with beds or layers of iron pyrites.
23	1835	Monteith.	Lime water.	Immersion.
24	1835	?	Solution of rosin in oil of turpentine.	Rubbing with a hot solution.
25	1835	Moll.	Vapor of eupion and creosote.	Exposing to the action of the vapor of the eupion and creosote in closed and heated vessels.
26	?	?	Concentrated sulphuric acid.	Coating to carbonize the surface of the wood.
27	1837	Flockton.	Oil of tar and pyrolignite of iron.	Immersion.
28	1837	Granville.	Refuse water of salt works.	Idem.
29	1837	Letellier.	Chloride of mercury and solution of gelatine.	The wood is immersed in a solution of the chlorine, dried, and then coated with a slight layer of glue.

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No.	Date.	Discoverer.	Preparation Employed.	Mode of Application.
30	1837	Gotthill.	Resinous solutions; as, for instance, tar and oil of turpentine, with the addition of salt.	Immersion from one to two hours in a solution heated from 275 to 399 deg. Fah., with or without application of pressure or a vacuum.
31	1837	Margary.	Solution of sulphate or acetate of copper	The wood first dried is then immersed in the solution.
32	1837	Industrial Society of Annaberg.	Soluble glass and hydrochloric acd.	The wood is immersed for thirty days in the soluble glass, and then placed in water acidulated with hydrochloric acid, washed, dried, and rubbed with oil.
33	1838	Treffy.	Salts which mutually decompose each other, as, for instance, (a) Chloride of tin or copper, (b) soda or lime water.	Alternate immersion in the liquids.
34	1838	Burnett.	Chloride of zinc.	Immersion of from ten to twenty days.
35	1838	Bethell.	Bituminous liquors, or those which contain creosote; for instance, oil of tar, pyrolignite of iron deprived of ammonia.	Extraction of the air, and introduction of the preparations by means of powerful pressure.
36	1839	Boucherie, and afterwards Uzielli.	Pyrolignite of iron, pyroligneous acid, muriate of lime, sulphate of copper, chloride of mercury, etc.	The solutions are introduced by the natural absorbing power of the living tree, or incorporated with the wood immediately after it is cut down.
37	1840	Feiselli.	Substances which mutually decompose each other, as, for instance, soluble glass, and afterwards dilute sulphuric acid, or solutions, first of alum, and afterwards of potash.	The wood is first steamed in a cylinder, the solution of alum or other salt is then introduced and boiled by steam; the alum fixed in the wood is then decomposed by solution of potash.
38	1840	Munzing.	Sulphate of muriate of protoxide of manganese, the refuse liquor of the chlorine works.	Immersion in the solution.
39	1841	Pons.	Solution of nitrate of iron, saltpetre, alum, and ferocynanide of potassium.	Idem.
40	1841	Payne, and afterwards Banner.	Salts which mutually decompose each other; as, for instance, muriate of lime, sulphate of iron and potash, and alum and potash.	The wood is placed in an iron cylinder, in which a vacuum is produced, and then filled with the first solution, which enters the wood by powerful pressure; this so-

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No.	Date.	Discoverer.	Preparation Employed.	Mode of Application.
				lution is then run out and the second introduced, when the pressure is again employed; in some cases it will be found necessary to dry the wood either partially or entirely between the first and second saturations.
41	1842	Timperly.	Chloride of mercury.	Immerson.
42	1843	Parkes, afterwards Passey, 1845.	Caoutchouc dissolved in carburet of sulphur eupion.	Coating or impregnating.
43	1843	Earle.	Solution of sulphate of iron or copper.	Immersion.
44	1844	Burkes, and after Reichenbach.	Soluble glass and sulphate of iron.	The wood is first steamed, then impregnated with solution of sulphate of iron, and lastly with the soluble glass.
45	1845	Ransome, and afterwards Newton.	Solution of silica in caustic soda (soluble glass), afterwards decomposed by an acid.	After having expelled the air from the pores of the wood, the solution of soluble glass is introduced by pressure; afterwards place the wood a short time in a diluted acid.
46	1846	Venzat and Banner.	Solution of sulphate or muriate of copper, afterwards decomposed by baryta.	Impregnation, as No. 40.
47	1846	Payne.	Solutions of metallic sulphurets (lime and barytal), decomposed afterwards by an acid or metallic salt (sulphate of iron, etc).	Extraction of the air by the vapor of water, and alternate introduction by pressure of the preparations which can decompose each other, as No. 40, so as to leave in the wood a deposit of sulphur or metallic sulphuret, insoluble, and of sulphuret of lime.

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Mr. Wade recommended the impregnation of timber with resinous or oleaginous substances (preferring linseed oil to whale oil), or with common resin dissolved in a tank of caustic alkali, and that the timber should afterwards be plunged into the water acidulated with any cheap acid or with alum in solution.

In 1811 Mr. Lukin undertook to treat wood by burying it in pulverized charcoal in a heated oven. He erected a large kiln in Woolwick Dockyard, but an explosion took place on the first trial before the process was completed, which proved fatal to eight of the workmen and wounded twelve. The explosion was like the shock of an earthquake. The experiment was not repeated.

In 1815 Mr. Ambrose Boydon, of the English Navy Office, strongly advocated that timber blocks and tree nails of ships should be first boiled in lime water and that they afterwards should be boiled in a thin solution of glue, by means of which the pores of the wood would be filled by a hard substance insoluble in water, which would not only give the timber durability by preventing vegetation, but would increase their strength. Glue, he thought, might be used with lime water, or glue and lime water mixed together.

In 1817 Mr. William Chapman published the results of several experiments he had made on wood with lime, soap and alkaline salts. He recommended the use of a sulphate of copper or blue vitriol.

In 1832 Mr. Oxford took out a patent for an improved method of preventing decay of timber. The process proposed was as follows: "The essential oil of tar was first extracted by distillation and at the same time saturated with chlorine gas. Proportions of oxide of lead, carbonate of lime and carbon of purified coal tar were ground and were mixed with oil and the composition was then applied in thick coatings to the substances intended to be preserved."

Active progress in timber preservation dates from the year 1832. During this year Mr. Kyan patented in England the process of corrosive sublimate, or bichloride of mercury, for preventing decay of timber. Corrosive sublimate has the strongest antiseptic properties among metallic salts, therefore its action is highly preservative, but it has several disadvantages. This process is usually called "Kyanizing," after the name of the inventor. It consists of steeping the wood in a solution of corrosive sublimate, the strength of which is usually one pound of salts to ninety-nine pounds of water. The work is usually performed in open masonry pits, without pressure, because of the corrosive effects of the chloride of mercury on metal. It is a very slow process compared with those in which the wood is impregnated under pressure. The process is still used in a small way for impregnating railroad ties in Southern Germany, and there are a couple of small plants

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in our New England States. Kyanizing was introduced in England in 1836, but has gone out of use long ago. The process is suitable for treating timbers on a small scale only. Chloride of mercury corrodes iron and steel, and therefore retorts made of this material are impracticable. Simple immersion being found imperfect as a means of injecting the sublimate, Mr. Kyan made an attempt to improve the efficiency of the solution by forcing it into the wood by pressure process. Wooden closed tanks were substituted for the open ones; forcing pumps were added to the operation. Although Mr. Kyan patented his process in 1832, Sir Humphrey Davey had previously used a weak solution of sublimate, to be used as a wash where rot made its appearance. Mr. Kyan, however, was the first to apply it to any extent.

Five years after Mr. Kyan's invention, namely, in 1837, a Mr. Flockton invented a process for preventing decay by saturating timber with oil of tar and acetate of iron. But little is known of this invention; we believe it was a failure. During the same year Mr. Flockton's process was made known, a Frenchman named Letellier recommended saturating timber in a solution of corrosive sublimate and, when dry, in one of glue. During this year Mr. Margary took out his patent for applying sulphate of copper to wood. His patent, as well as Burnett's, taken out a year later, show that the chemical was intended to be introduced into the wood by soaking, or immersion; but this practice was soon abandoned and injection by pressure substituted.

In 1838 Sir William Burnett, formerly Director General of the Medical Department of the English Navy, made known to the public his new process for treating wood. The invention consists of destroyng the tendencies of certain vegetable and animal substances to decay by submitting them to the action of chloride of zinc. The degree of dilution recommended by Mr. Burnett is one part volume by fifty parts of water. At first the method of impregnation was by immersion in open tanks. In 1847 a powerful cylinder of Burnett's construction, hermetically closed, was laid down adjoining the saw-mills in Woolwich Dockyards. With this it was possible to treat large timbers and to apply a pressure as high as 140 pounds per square inch and extracting the moisture, by means of creating a vacuum, from the pores of the wood, which were afterwards filled with chloride of zinc. This process is usually called "Burnettizing," after the name of the inventor. Chloride of zinc is not considered as strong an antiseptic as chloride of mercury, and even considerably less than sulphate of copper, but it is much cheaper than either of these, and is, in fact, the cheapest of all the preservatives. In general, no reaction takes place between chloride of zinc and iron when spikes are driven into zinc-treated ties, but the drawback in its use is that it is, like chloride of mercury, easy soluble and therefore apt to leach out

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of the wood impregnated with it. The substance is, therefore, unsuitable for timber to be used in water, such as piling and dock timbers, but it is an excellent preservative for railroad ties and other timbers where they are not constantly exposed to the action of water. This process is in use on many railroads in Europe and America.

In Germany "Burnettizing" meets with much favor. The Stuttgart Technical Convention of 1887 expressed itself as follows:

> "As the experience of those railroads that have from twenty-five to twenty-six years impregnated their sleepers with chloride of zinc, under pressure, after steaming and abstracting the sap, has been satisfactory, and as the system costs only one-third or less compared with impregnation with creosote or corrosive sublimate, many of the railroads have adopted the chloride of zinc process."

A report of a committee to the American Society of Civil Engineers, June, 1885, recommended Burnettizing as the best method for preserving cross ties.

The wood is usually submitted to live steam in the cylinders before impregnation. Steaming the wood under pressure of 15 to 20 pounds per square inch, as done in Germany, preparatory to injection of the solution, no doubt adds to its durability. Tredgold—no mean authority—considers that boiled or steamed timber shrinks less and stands better than that which is naturally seasoned. Barlow, another good authority, is of the opinion that the seasoning goes on more rapidly after the piece is steamed and stacked in open air.

Modifications of zinc chloride processes have been proposed to correct the principal objection above mentioned. One of them is known as the B. M. Process (Bruning-Marmetschke Process for preserving wood, H. Bruning, Manager, Schopfurth, Germany). The process consists of adding aluminum sulphate to zinc chloride, and it is claimed that zinc chloride salts are made more permanent in the wood.

We now arrive at the modern creosoting process, which was invented by Mr. John Bethell, of England, and patented by him in 1838. Mr. Bethell's patent relates more particularly to the method of treatment rather than the kind of preservative employed. This consists of the use of closed vessels that contained the timber, in which first a vacuum was produced, the timber being partially surrounded by the chemicals, and being preferably placed in an upright position; then fully surrounded by the chemical and pressure applied to force it into the wood. Mr. Bethell mentions dead oil of coal tar as one of the preservatives which can be used. Three years prior to this a patent was issued to Franz Moll for a treatment consisting of a preliminary heating in a closed vessel, then the admission of the vapor of the first distillation from coal

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tar, followed by soaking in this same distillate, which he called eupion—the object of all of which was to season the wood and prepare it for the next treatment, which was soaking in the second distillate, or, as he called it, "creosote" oil. However, this treatment has never been followed in practice, as it wastes the first distillate; and Bethell's method of treatment using the dead oil, which is the second distillate of coal tar, called by Moll "creosote," supplanted it.

Previous to the time of Mr. Bethell's invention practically all impregnation of wood was accomplished by immersion in open tanks or open boilers, and his method of injecting the material into the wood placed in cylinders, hermetically closed, by pressure, it may be said that he is the inventor of what is commonly known today as the **pneumatic pressure process**—at any rate, one of the first to use this process to any appreciable extent. The pressure method of impregnation is the process now employed generally. Open tanks and open boilers are still used to treat material, but only in small quantities.

It is not our intention to say much about creosote oil. More has been said and written about this one preservative than all of the others put together. Suffice to say that creosote oil, now so extensively used for preserving wood, is obtained from coal tar, petroleum tar and wood tar, which, when submitted to distillation, is found to contain a light oil, a heavy oil (creosote), and pitch. Various quantities of creosote are injected into the wood, ranging from five pounds to twenty-two pounds per cubic foot of timber. In France, Belgium and Holland it is customary to inject into the wood all the oil it will imbibe. In other words, to refusal of the timber to take any more.

Creosoting is far from being a cheap process, and for this reason, perhaps more than others, it was slow in being adopted in this country. From 1885, when treatment of ties was undertaken on an extensive scale by the Atchison, Topeka & Santa Fe Railroad at Los Vegas, New Mexico, until 1905, or twenty years "Burnettizing," or zinc chloride process, was used almost exclusively.

Among the many attempts to preserve woods, those processes discovered by Sir William Burnett and Mr. John Bethell, both Englishmen, have proved the most successful and upon which all of the subsequent methods and improvements in treating timber are founded.

A Frenchman named Breant patented his discovery in 1831. It was adopted to a considerable extent in France. Breant's apparatus consisted of a very ingenious machine, which, acting by pressure, caused liquids to penetrate into a mass of wood of large diameter and of considerable length. He may, therefore, be re-

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garded as having solved the problem of penetration in a scientific, though not practical, manner.

In 1839 Mr. Boucherie, a Frenchman, patented his process, which consisted in causing a solution of sulphate of copper to penetrate to the interior of freshly cut woods to preserve them from decay. He occasionally used the chloride of calcium, the pyrolignite of iron, prussiate of iron, prussiate of copper and various other metallic salts. As a general rule, sulphate of copper, commonly known as blue vitriol, was used. In this process the liquid is taken up by the tree, either whilst it is growing in the earth or immediately after it has been cut. Not more than one month should elapse before the timber is operated upon, and the sooner it undergoes the process after being felled the better. This process is still in use in France for treatment of telegraph poles, and the method of impregnation is by hydrostatic pressure. After the trees have been felled the poles are ranged horizontally side by side, the butt ends about one foot higher than the top ends. Iron caps with a pipe connection are fastened to the butt ends of the poles. A wooden tank fifty feet above the ground contains the blue vitriol solution. The solution in the reservoir is conveyed by means of a flexible tube to the cap on the end of the poles and is forced through them from end to end by the hydrostatic pressure. This process or treatment is undoubtedly effective, but is an exceedingly slow method.

Sulphate of copper can also be used in a 1½ to 2 per cent. solution for impregnating by pneumatic pressure; but as in this case the cylinders have to be made of copper, this method is not popular.

Mr. Blythe, of Bordeaux, France, patented a process of preparing wood by the injection of heated solutions of sulphate of copper, heated to nearly boiling point and placed in a lead cylinder, protected by wood. In 1846 80,000 ties treated by this process were laid down in French railways and found to give good service. Mr. Blythe also invented another process called thermo-carbolization. This process consisted in treating wood with carburetted steam to extract the saps and water and at the same time inject it with creosote held in suspension. This being a slow and expensive method it has not met with favor.

In 1841 Mr. Payne patented his inventon. The materials employed in Mr. Payne's process are sulphate of iron and sulphate of lime both held in solution with water. The timber is placed in a cylinder in which a vacuum is created; a solution of iron is then admitted into the vessel, the fluid being readily absorbed by the assistance of the vacuum. The sulphate of iron is then withdrawn and another solution of sulphate of lime is run into the cylinder, which enters the substance of the wood in the same manner as the former solution, and these solutions react upon each

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other and form new combinations—muriate of iron and muriate of lime. One of the most valuable properties of timbers thus prepared is the perfect incombustibility. When it is exposed to the action of flame or strong heat it simply flounders and emits no flame. The greatest drawback consists in the increased difficulty of working the timber.

Many other processes were suggested by European wood preservers, but it will be sufficient to mention one more, that of Julius Rutger's Zinc-Creosote Process, patented in Germany in 1874. The process consists of four operations: (1) steaming the timber; (2) producing a vacuum and admitting the preservative fluid; (3) the application of the pressure pump, and (4) application of final vacuum to hasten drying of the material. The preservative is a mixture of creosote oil and zinc chloride. A modification of this process has been employed at several plants in the United States and is known as the Card process.

Mr. Samuel B. Boulton, of London, England, obtained a patent in 1879, for process of treating wood. He gets rid of the moisture in the timber simultaneously with the injection of creosote. The wood, either fresh or seasoned, being placed in the cylinder, creosote heated to over 212 degrees Fahr. (the boiling point of water), is admitted, and the air pump is used to exhaust any or all of the water thereby converted into steam, the theory being that the water is simultaneously replaced by warm creosote, which, of course, penetrates the wood more easily than would be the case at a lower temperature, the force pumps being also used if necessary.

While numerous experiments were going on in England, France and Germany to discover the best methods of treating woods, Americans were not idle. The most noted men in the development of the industry in this country are Mr. Octave Chanute, who designed and built several of the early plants and was interested in their operation for nearly twenty years; Mr. Samuel Rowe, who designed the pioneer treating plant at Los Vegas, New Mexico, and who wrote the first American book on Timber Preservation worthy of mention; Mr. A. A. Robinson, who was Chief Engineer of the Santa Fe in 1885, after four years of experimental work, had works built in New Mexico; Mr. Julius Kruttschnitt, of the Southern Pacific, who built works at Houston, Texas, in 1891, and Mr. H. U. Mudge, now President of the Chicago, Rock Island & Pacific Railway, a notable student of wood preservation and one who has done much towards its development and improvement. Among the array of American inventors and practitioners, we make special mention of Seeley, Hayford, Hasselmann, Wellhouse, Isaacs, Curtis and Card. Mr. Seeley was granted a patent in 1867 on a method of impregnating, consisting of immersing the timber in an iron tank filled with oil, heating it to drive out the moisture,

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replacing the hot oil suddenly with cold oil, whereby it is forced into the wood by condensation. A patent to Hayford in 1872 added to the use of steam for seasoning, the pressure of hot air to prevent the checking of the timber by more rapid seasoning of the exterior portions of the wood. This method was advocated and followed by E. R. Andrews in his works at Boston. A patent to Messrs. W. G. Curtis and J. B. Isaacs, of the Southern Pacific Railroad, was granted in 1895, covering a process identical with Mr. S. B. Boulton's, except that they did not use the vacuum during the boiling. The philosophy of both is that water is vaporized at 212 degrees, while the oil does not vaporize under 365 degrees. A temperature maintained between these two will drive off the moisture of the water, which can be replaced by oil with pressure. Both of these methods have been used in this country with success.

There is one other treatment which was suggested some years ago and which has some very desirable theoretical features about it, namely, the Hasselmann process. This consists in boiling the timber in a solution of several substances, the principal one being sulphate of iron. There have been a number of treatments proposed whose value was based upon the securing of a chemical reaction in the wood itself, but there has been a good deal of skepticism about the securing of such reactions, and the Hasselmann process seems to be the only one in which clear evidence has been given of success in that regard.

The principal objection to the use of zinc chloride, sulphate of copper and other mineral salts is that such salts are more or less soluble in water. They are effective germicides and as long as they remain in the wood in sufficient quantity will prevent decay. The solutions containing metallic salts are more readily injected than oils, consequently it has been attempted to use them in conjunction, and various methods have been patented for this purpose. Mr. J. P. Card (father of an esteemed member of this Association bearing the same name), proposed a method of first injecting a small amount of tar oil, then immediately thereafter injecting a solution of zinc chloride. He claimed that by this means he secured a much better distribution of the oil in the wood than was possible with the ordinary injection of the same amount of oil and at the same time thoroughly protecting the interior of the stick with zinc chloride. Mr. Card introduced the Wellhouse process on the Atchison, Topeka & Santa Fe at Los Vegas, New Mexico, works built in 1885. This process consisted of the injection of zinc chloride, followed by injections of solutions of glue and tannin, the object of the two latter being to plug up the ducts of the timber by the artificial leather formed by the glue and tannin. This treatment has been in use in this country for a number of years with very satisfactory results.

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Another treatment used considerably in this country, is the zinc-creosote, or Allardyce, process, which consists of an injection of a 2 per cent. solution of zinc chloride into the wood, followed immediately by an injection of about three pounds of creosote oil per cubic foot. A number of ties treated this way by the International Creosoting and Construction Company, at Beaumont, Texas, were laid in the track in the year 1900, and a large percentage of them are still in the service at this date.

A second process of zinc-creosote, known as the Card process, was introduced in America a few years ago. It differs in the Allardyce in the fact that an emulsion of zinc chloride and creosote is made and forced into the wood in one operation.

Mention might be made of several other men and processes connected with the timber treating industry in this country, but suffice to say that America has been alert and active in the development of this important industry.

Such are the principal patents, suggestions and inventors up to the close of the last century. Since the beginning of the present century there have been several more processes brought before the public, particularly by Americans, but space does not permit mention of them at this time.

Preservatives.

Numerous ingredients have been proposed for the preservation of timber from decay. In this paper we can only give a recapitulation of the chief ones which have been tried, and some recommended, to prevent the decomposition of timber and the growth of fungi:

Acids: Sulphuric, Tar, Vitriolic.
Carbonates of Barytes, Potash and Soda.
Chlorides of Mercury, Sodium and Zinc.
Sulphates of Alumina, Barytes, Copper, Iron, Lime, Magnesia, Soda, Zinc.
Muriate of Soda.
Nitrate of Potash.
Fish, Whale and other animal oils.
Linseed, Cedar and other vegetable oils.
Petroleum and Crude Oils and other mineral oils.
Oils from distillation of tar obtained from coal, petroleum and wood (creosote).
Molasses and Low Syrups.
Wax, Glue.
Resins and Gums of different kinds.
Quick Lime or Hydrate of Lime.

The preservatives which found most favor and used widely both in America and Europe are, (1) chloride of zinc, (2) creosote oil, and (3) petroleum, or crude oil. Mixtures of various ingredients were also used. They were about as numerous as patent medicines, and some of them about as worthless. The most popular mixture of all is creosote oil and chloride of zinc, and, in our opinion, this combination possesses many merits.

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Methods of Impregnation.

The methods of impregnation vary almost as greatly as the preservatives employed in them, but may be classified into two main groups, namely, (1) impregnation by immersion, (2) impregnation by pneumatic pressure.

Immersion is the oldest of methods, long since practiced with milk of lime and brine solution, and was adopted in Kyanizing with a solution of chloride of mercury, and also with other salts. This is the simplest of all methods. Converted woods, such as ties, fence posts, plank or timbers of any kind, are merely steeped and weighed down in liquid contained in a large trough or vat made of wood or iron. The timber must be well seasoned. The solution will not penetrate damp or green wood. Soft woods, about the size of ties or fence posts, need be steeped for a period of eight or ten days, while hardwoods require twelve to fourteen days when immersed in cold solutions. This method is no longer employed on a large scale, but it can be conveniently used for treating fence posts or other material in a small way. The treatment by open tank methods can be expedited by placing the wood in an open tank or open boiler filled with the preservative substance and a fire kindled underneath. The boiling dissolves and extracts the saps and juices from the wood and the preservative is absorbed by capillary attraction. Of course the tank or boiler must be made of iron or steel if a fire is kindled underneath, and in selecting the preservative it must be such as will not corrode the metal. Sulphate of copper or chloride of mercury cannot be used in metal tanks, but zinc chloride, creosote oil, petroleum or crude oil are practicable.

Pneumatic pressure, by means of force pumps, was originally applied by Breant and Payne, and was the method adopted with chloride of zinc by Burnett, and with creosote oil by Bethell; but these older methods have since been improved upon by Blythe, Boulton and others. The pressure process is adapted to the use of chloride of zinc, creosote oil, crude petroleum oils, or any mixture of these substances. This method of impregnation is so well understood that it is unnecessary to describe it in this paper. Suffice to say that the timber is placed in the cylinders six to nine feet in diameter, one hundred to one hundred and forty feet long. A door hermetically closes the cylinder into which the fluid is introduced. Pressure is applied to the fluids in the cylinder, and ranges from a few pounds to two hundred pounds per square inch, as desired by the operator. The wood must be thoroughly dry at the time of injection, otherwise the moisture or vapor will resist the entrance of the preservative. Incidentally, the writer desires to emphasize the necessity of thorough seasoning or drying of timber before the injection of the preservative. It is by far the most important factor influencing the quality of the work. It

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is more important than the kind of preservative used and more important than the method of impregnation adopted, for if the timber is not dry the preservative cannot be forced into it, no matter what method of impregnation is employed. The preservative should be forced into the wood until it refuses to absorb any more in order to secure as thorough impregnation and dissemination of the preservative in the wood as possible.

Thorough seasoning can only be accomplished by artificial means. Various methods have been tried and recommended. The French Eastern Railway of France have used the drying ovens or kilns to complete the seasoning of their ties. That road, which is distinguished for doing the best work of any in Europe, commenced to use the kilns to dry wooden ties, which were afterwards impregnated with creosote oil in closed cylinders by vacuum and pressure process (Bethell Process), in 1865. In 1874 they built a new treating plant at Amagne, France. Instead of constructing hot-air dry kilns with direct acting furnaces, they employed dryers with hot-air heaters, giving a more methodical heating. The ties are first air-seasoned for several months and then placed in ovens. The artificial seasoning simply completes air-seasoning and permits the plant to operate at all seasons of the year, besides insures thorough impregnation of the wood. This mode of drying ties has given entire satisfaction, and with the precaution taken in drying, the ties are not deformed. Some ties show small checks and splits, which close up after creosoting. This method is employed by several French companies that treat their ties either by the Burnett or Bethell processes. The Western Railway of France notaby have built a plant at Surder, France, simliar to that built by the French Eastern Railway at Amagne. Undoubtedly kiln drying of ties and timbers before impregnation is the only proper method of putting the material in good condition and securing thorough and uniform seasoning.

Development of the Industry in the United States.

Before the advent of railways the treatment of wood in Europe was primarily for use in construction of merchant and war ships, which were constructed almost entirely of wood, and in America for locks and canals. Small quantities of treated timber were used for structural and other purposes. The invention of the steam locomotive and railway gave rise to the necessity for protecting the wooden ties, or sleepers as they call them in Europe, from decay. From this period may be reckoned the active progress in wood preservation. The treating of railway ties with a preservative of some kind increased rapidly, and very soon the quantity of wood treated in the form of railway ties exceeded that used for all other purposes. This ratio is constantly increasing, and at the present time perhaps 90 per cent. of the wood treated in the United

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States consists of railway ties; the remaining 10 per cent. consists of piling, paving blocks, dimension timbers, etc.

Inasmuch as the real active progress in the development of timber preservation did not occur until the advent of railways, and the development of the latter in America was contemporaneous with that of European countries, it may be said that the development of the wood preserving industry was contemporaneous in all countries. A good many experiments were made in America, based largely, however, upon European experience, from which much data was obtained.

The first recorded use of treated ties were some chestnut ties treated with chloride of mercury (Kyan's process) and laid on the Northern Central of Maryland in 1838. Some oak ties treated by the same process were laid in track of Chesapeake and Ohio Railroad in 1840. Presumably both of these were trial lots to determine the value of the process. It is recorded that these ties gave a service of twelve to fifteen years.

The first treating plant worthy of name was probably that at Lowell, Mass., built in the year of 1848 by the proprietors of the locks and canals at that point. The plant consisted of two wooden tanks, each fifty feet long, eight feet wide and four feet deep, in which the timber was immersed in accordance with the Kyanizing process, using chloride of mercury. Chloride of zinc was also used in treating wood at this plant. It was here used for bridge work in connection with canals and not with railroads. This plant is still in use and is now owned by Otis Allen & Son, of Lowell, Massachusetts.

The growth of the treating industy in the United States was slow during the following three or four decades, only a few small plants being constructed. In 1856 the Vermont Central erected Burnettizing works and treated ties for a few years, when the plant was abandoned before any results favorable or otherwise were apparent. Their reason for this was that the delays consequent upon waiting for treated timbers were too great to admit of a continuance and they lost faith in the scheme, only to find that twenty-five years later that they even then had hemlock ties in a side track which had been part of these treated at this plant, and were still nearly sound in spite of their long service.

In 1860 the Chicago, Rock Island & Pacific Railroad built a "Howe" truss bridge 1200 feet long, the timbers in which were Burnettized, and in 1882 these were reported as being still in use and in fair condition.

In 1861 the Erie Railroad built a plant at Oswego, N. Y., confining the treatment to bridge timber and planking. It was burnt down in 1869 and not rebuilt, as the results from the treatment were not considered satisfactory. Subsequent inquiry by a committee developed the fact that the treatment was not well

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or carefully done, and the Superintendent of the works afterwards admitted that the material was "hurried through" the process and poor treating done, the General Superintendent of the railroad stating that the "timber was treated in the winter, was full of frost and that the zinc chloride had no effect." No further comment is necessary, as inferior work in the treating plant today will produce simliar results.

The Philadelphia, Washington & Baltimore Railroad and the Philadelphia & Reading Railroad each built works to treat material with zinc chloride and started to treat their ties, the former in 1863 and the latter in 1867. They found that ties would last against decay, but "were brittle as a carrot," caused, of course, by the solution used being too strong, so that the ties were overtreated and had to be removed. However, they were used as fence-posts, and it is said they lasted a long time. It is not definitely known what solution the P., W. & B. R. R. used, but that of the P. & R. R. R. is said to have been 3¼ per cent. strong.

In 1866 the Chicago, Rock Island & Pacific Railway laid 2,000 pine, tamarack and cedar ties in their main track just west of Englewood, Ill. These ties were treated with zinc chloride. In 1882, after sixteen years' service under heavy traffic, 75 per cent. of the hemlock were still in the track and good for two or three years longer, while the pine and cedar came out in fifteen years. The natural life of the untreated hemlock ties in that locality, and under similar conditions for traffic and ballast, was said to be five years.

A number of Burnettized or zinc-clhoride treated ties, consisting of maple, beech and hemlock, were laid in the main line of the Lehigh & Susquehanna Railway in 1867. In 1883 the greater number were still in the track and reported good for seven or eight years longer service.

The Louisville & Nashville Railroad built a treating plant at West Pascagoula, La., in 1875-6. The plant was arranged to treat material by the pressure process with creosote oil. It was built primarily to treat piles, stringer caps and ties used in construction of trestles and docks. Creosote timbers was extensively used in the New Orleans, Mobile and Texas Railroad, extending from Mobile, Ala., to New Orleans, La. Many important structures having been built of creosote timber from 1876 to 1879. The L. & N. R. R. acquired control of the road from Mobile to New Orleans in 1880. In 1882 large quantities of creosote piles, stringers and caps were used in construction of trestles and docks of the Louisville & Nashville Lines in the city of Pensacola, Florida and vicinity. The earlier use of creosote piles was more for the purpose of protecting them from attacks of sea worms or toredo navalis.

However, in more recent years large quantities of creosoted piles and sawed timber have been used by the Louisville & Nash-

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ville Lines when not subject to attack of sea worms and have been used mostly for economical reasons.

About 600 long leaf yellow pine ties, which were creosoted at this plant and placed in the track in 1877-1878, remained in the track until June, 1905. The amount of oil injected into these ties is not known, but it is estimated at 15 to 18 pounds per cubic foot or 45 to 55 pounds per tie.

In 1879 the New Orleans and North Eastern Railroad built a pressure plant to treat with creosote oil, at Slidell, La. It was originally built for the purpose of creosoting the timber used in building a trestle across Lake Ponchartrain. After this work was done the plant was closed and stood idle until it was sold to the Southern Creosoting Company, in the latter part of 1902.

The Houston & Texas Central Railroad also built a treating plant at Houston Texas in 1876 to treat piling and timbers generally with creosote oil.

It is not to be supposed that every experiment made in this new field was a success. They were frequently dependent upon men without much prior experience in this line, and who, to some extent, were feeling their way. Neither was it known that, where zinc chloride was used successfully in the case of bridge timber, that it could also be satisfactory with crossties. It seemed to have been tried in some cases where there was necessity of economy irrespective of other considerations, and failure was not, therefore, a cause for surprise. In the majority of the earlier trials, however, the results were favorable, so that about 1878 several other railways made tests with treated cross ties with such success that in 1885 the Atchison, Topeka & Santa Fe Railroad erected a treating plant at Los Vegas, New Mexico, and because of continuous operation of the same to 1906 may be considered the pioneer company in its line. It is true this plant was built eleven years later than the L. & N. R. R. plant at Pascagoula, but it should be borne in mind that this plant was not built primarily for the treatment of railroad ties, as is the case with the Los Vegas plant. The latter plant had two cylinders, and for some years all the ties and timbers treated was by the zinc-tannin process, otherwise known as the Wellhouse. In part of 1890 and all of 1891 and part of 1892 zinc chloride alone was used as a preservative, and from 1900 to date of dismantling of the plant that treatment alone was used.

In 1886 the Chicago, Rock Island & Pacific Railroad, which had previously tried the Burnettizing process with success, made a contract with Card & Chanute (later the Chicago Tie Preserving Company) to treat a specific number of hemlock and tamarack ties each year by the Wellhouse process. So satisfied were they with the results that as each contract expired it was renewed from time to time with an increased quantity. Mr. Octave Chanute figured

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up the average life of these ties treated at the Chicago works by three different methods and found it to be 10 2-3 years.

In 1887 the Southern Pacific (Atlantic System) began treating Texas soft pine ties at a leased plant, and in 1891 built one of their own at Houston, Texas. To this company's officials belongs the credit of being the only road having complete record of service given by treated ties from the start. Only the Burnettizing method has been used on that system. So satisfactory were the results that the Pacific System of the same company erected a portable plant in Oregon in 1894 and since then have treated practically all of the ties used on that part of the system.

The heavy increase in cost of ties of durable quality caused several of the Western roads to begin the use of certain woods, the life of which they knew to be very short, but which could be materially lengthened by treatment. Many plants were therefore constructed, either owned by the railroads themselves or by private concerns who treat under contract.

The Atchison, Topeka & Santa Fe in 1897 made a contract with the Texas Tie & Lumber Company, of the Santa Fe, to build a plant at Somerville, Texas, for treatment of their ties with zinc chloride. A second treating plant was also built by the Santa Fe at Bellemont, Arizona, in the same year.

In 1899 the Chicago, Burlington & Quincy built a plant at Sheridan, Wyoming, for treating lodge-pole pine ties from Wyoming and the Black Hills. The Great Northern Railway built a plant at Kalispell, Montana, in 1901, for treating Montana pine, tamaracks, etc. The Missouri, Kansas & Texas Railroad built one at Greenville, Texas, in 1901, and the Mexican Central Railway one at Aguas Calientas, Mexico, about the same time.

At the end of the year 1903 there were twenty-seven timber-treating plants in the United States as shown on the accompanying list.

Railroad ties constituted fully ninety per cent. of the total quantity of material treated during that period, and fully ninety-five per cent. of the ties were treated with Chloride of Zinc, and the remaining five per cent. with Creosote Oil. Some of these plants have since been dismantled or moved elsewhere, such as the Los Vegas plant and the Bellmont, Ariz., plant, of the A. T. & S. F. and the three portable plants of the Southern and Union Pacific Railways.

Growth of the Industry in Europe and America.

The statistics of European Railways relating to number of ties treated from the beginning are meagre and difficult to obtain, and the author can only give an approximation, as can be found in the voluminous and scattered records in various languages, and does not pretend that it is accurate, but may be of some interest to the reader in comparing the figures with those given later for the United States.

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Timber Treating Plants in the United States, Dec. 31, 1903.

No.	Location.	Year built.	Name of Company.	Preservative.	Kind of wood.	Number of Retorts	Estm't. capacity per an. ties
			Open Tank Process.				
1	Lowell, Mass.	1848	Locks & Canal Co.	Chl. of Mercury.	Various	2	30,000
2	Portsmouth, N. H.	1875	Otis Allen & Son.	Chl. of Mercury.	Various	4	40,000
			PNEUMATIC PRESSURE PROCESS				
1	W. Pascagoula, La.	1875	Lville. & Nash. Ry.	Creosote.	Pine	2	400,000
2	Long Island City, N. Y.	1878	Eppinger & Russell.	Creosote.	Pine	4	800,000
3	Slidell, La.	1879	Queen & Cres. Ry.	Creosote.	Pine	1	300,000
4	Portsmouth, Va.	1881	Wyckoff Pipe Creosoting Co.	Creosote.	Pine	1	100,000
5	Seattle, Wash.	1884	Colman Creo. Co.	Creosote.	Pine	2	200,000
6	Los Vegas, N. Mex.	1885	A., T. & S. F. Ry.	Zinc-tannin.	Pine	3	500,000
7	Chicago, Ills.	1886	Chgo. Tie Pres. Co.	Zinc-tannin.	Hemlock	4	500,000
8	New Orleans, La.	1888	N. O.Wood Pres. Co	Creosote.	Pine	1	300,000
9	Oakland, Cal.	1889	Sou. Pac. Rv.	Zinc-chloride.	Pine	5	1,500,000
10	Perth Amboy, N. J.	1890	U.S.Wood Pres. Co.	Creo.-Resin.	Pine	4	1,200,000
11	Houston, Tex.	1891	Sou. Pacific Ry.	Zinc-chloride.	Pine	5	1,500,000
12	Cal. & Ore. (Portable).	1894	Sou. Pacific Ry.	Zinc-chloride.	Pine Fir	2	1,000,000
13	Norfolk, Va.	1896	Nor. Creo. Co.	Creosote.	Pine	4	900,000
14	Somerville, Tex.	1897	Texas Tie & Lbr. Co	Zinc-chloride-Creosote.	Pine	6	2,000,000
15	Beaumont, Tex.	1897	Int. Creo. & Con. Co	Zinc-chloride-Creosote.	Pine	1	500,000
16	Bellmont, Ariz.	1898	A., T. & S. F. Ry.	Zinc-tannin.	Pine	2	350,000
17	Mt. Vernon, Ills.	1899	Chgo. Tie Pres. Co.	Zinc-tannin.	Oaks	1	200,000
18	Sheridan, Wyo.	1899	C., B. & Q. Ry.	Zinc-chloride.	Pine	2	500,000
19	Greenville, Tex.	1901	M., K. & T. Ry.	Zinc-tannin.	Pine Gum	3	900,000
20	Kalispell, Mont.	1901	Great Nor. Ry.	Zinc-tannin.	Pine Fir	4	1,200,000
21	Texarkana, Ark.	1902	Int. Creo. & Con. Co	Zinc-chloride	Pine	2	1,000,000
22	Alamogordo, N. Mex.	1902	Alamogordo Lum.Co	Zinc-tannin.	Pine	2	600,000
23	California (Portable).	1902	Union Pacific Ry.	Zinc-tannin.	Pine	2	600,000
24	Oregon (Portable).	1902	Oregon Short Line.	Zinc-tannin.	Pine Fir	2	600,000
25	New Orleans, La.	1902	Amer. Creo. Wks.	Creosote.	Pine	2	400,000
26	Carbondale, Ills.	1903	Ayer & Lord Tie Co.	Creo. Zinc-Chl.	Oaks	6	2,500,000
27	Grenada, Miss.	1903	Ayer & Lord Tie Co.	Creo. Zinc-Chl.	Pine	2	800,000
					Total....	.....	21,350,000

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The Railway mileage of Europe, January 1st, 1909, is reported as 195,521 miles. Of this mileage Germany stood first (34,743), followed in their order by Russia (32,743), France (28,430), Austria-Hungary (24,261), United Kingdom (22,847), Italy (10,070), Spain (9,190), Sweden (7,677), Norway (2,931). European railways used a large number of metal ties and space their ties much farther apart than practiced in the United States, so that there are not so many wooden ties used per mile for maintenance in Europe as in the United States.

The number of wooden ties treated annually in Europe is about as follows: Germany, 4,000,000; Russia, 2,600,000; France, 3,000,000; Austria-Hungary, 2,500,000; United Kingdom, 2,300,000; Italy, 1,000,000; all other countries in Europe, 1,200,000; total, 16,600,000 ties. Thus the total quantity of ties treated annually in Europe is about one-half of the number treated in the United States during past year or two.

The total number of timber-treating plants in Europe is between 65 and 70. Approximately 85 per cent. of all wooden ties in use in Europe are treated.

In the United States the data is more copious and reliable. The author has compiled the accompanying statement from various government reports and publications. The steam railway mileage was obtained from Interstate Commerce reports, the electric and street railway mileage from the Electric Railway Journal of New York, for years 1900 to 1912, inclusive; previous to 1900 figures estimated by the author.

The number of ties used by steam and electric railways was obtained from Forest Service Reports from year 1907 to 1911; previous to 1907 from U. S. Census reports and estimated by the author. The number of ties treated from 1907 to 1911, inclusive, from Forest Service reports, previous to 1907 from various publications and estimated by the author. All figures for 1912 are estimated.

The proportion which treated ties formed of the entire number purchased is calculated and given for each year, also number of plants in operation from 1860 to 1912, inclusive, is stated.

Up to January 1st, 1900, approximately 15,000,000 ties were treated in the United States, of which about 14,500,000 were treated with chloride of zinc and 500,000 with creosote oil.

During the year 1903 the number of ties treated was 9,010,000, of which 8,400,000 were treated with chloride of zinc and 610,000 with creosote oil, and during the year 1905 approximately 14,890,000 ties were treated, of which 13,420,000 were treated with chloride of zinc, and 1,470,000 or about 10 per cent. with creosote oil.

During 1907 and 1909 the largest number of plants were built in the United States, being 12 in the former and 11 in the latter year.

The proportion which treated ties form to the entire number

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used has gradually increased from one per cent. in 1886 to 24 per cent. in 1912, and we see no reason why these percentages should not increase from year to year until the bulk of them receive a preservative treatment.

Our supply of timber is fast diminishing. We are consuming it at such a reckless rate that some of us may live to see a day of repentance. Aside from the great economy effected by the use of treated ties and timber, there should be in all of us the spirit of pariotism, which will urge us to husband the resources of our magnificent inheritance of Forests.

Table Showing Miles of Steam and Electric Railways, Number of Ties Used, Number Treated and Number of Plants in Operation from 1860 to 1912, Inclusive.

Year	Miles of Railroads in U. S.	Miles of Street and Electric Railroads in U. S.	Number of ties used by Steam & Electric Railroads	Number of ties treated	Percentage	Number of plants in operation
1860.....	30,626					
1870.....	52,922			From 1860 to 1885, excl.,		
1880.....	93,267			appx. 50,000		3
1885.....	123,320	3,000	50,000,000	120,000	.25	5
1886.....	125,185	3,120	51,000,000	590,000	1.00	5
1887.....	137,028	3,680	56,000,000	504,000	1.00	5
1888.....	145,387	4,112	60,000,000	644,000	1.00	6
1889.....	153,725	4,930	63,000,000	615,000	1.00	7
1890.....	166,703	5,241	68,000,000	600,000	1.00	8
1891.....	168,403	6,155	70,000,000	697,000	1.00	8
1892.....	174,784	7,040	72,000,000	790,000	1.00	9
1893.....	175,980	8,870	73,000,000	812,000	1.1	10
1894.....	178,412	8,949	75,000,000	920,000	1.2	11
1895.....	181,717	10,810	76,000,000	1,289,000	1.7	12
1896.....	183,111	12,133	78,000,000	1,307,000	1.5	13
1897.....	184,428	13,765	79,000,000	1,312,000	1.6	13
1898.....	186,396	15,942	80,000,000	1,826,000	2.3	13
1899.....	189,294	17,665	81,000,000	2,510,000	3.0	15
1900.....	194,262	19,314	85,000,000	2,800,000	3.2	15
1901.....	197,237	22,217	88,000,000	4,101,000	4.6	17
1902.....	202,471	25,592	90,000,000	6,180,000	6.8	22
1903.....	207,977	27,754	94,000,000	9,010,000	9.5	27
1904.....	212,394	29,548	96,000,000	12,800,000	13.3	30
1905.....	217,341	32,517	100,000,000	14,890,000	14.9	34
1906.....	222,635	36,212	102,834,000	16,880,000	16.4	39
1907.....	227,670	38,812	153,703,000	19,856,000	12.9	51
1908.....	231,333	40,247	112,466,000	23,776,000	21.1	57
1909.....	234,799	40,490	123,751,000	22,033,000	17.8	68
1910.....	238,609	40,088	148,231,000	30,544,000	20.6	75
1911.....	242,885	41,028	135,053,000	31,141,000	23.0	81
1912.....	244,000	42,000	140,000,000	33,600,000	24.0	84

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PART VI

Timber-Treating Plants in North America
with
Map Showing Forest Regions
and
Location of Plants

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TIMBER-TREATING PLANTS IN NORTH AMERICA DECEMBER 31st, 1912.

Compiled from Reports Made by the Various Managing Companies to the American Wood Preservers' Association.

By W. F. Goltra.

The necessity for a complete and authentic list of wood-preserving plants in the United States, Canada and Mexico and collateral information has long been felt by those interested in this industry.

Such lists as have been published heretofore possess meager information regarding the character, capacity and equipment of the plants, processes employed, kinds of woods and material treated, preservatives used and other useful information regarding the timber-treating industry. Until now it has been extremely difficult to gather sufficient information to enable one to compile such a report, but our Secretary, Mr. Angier, has secured complete data and the writer has undertaken to compile it to the best of his ability.

There are two general methods of impregnation, namely:

(1) Impregnation by immersion in open tanks or boilers, also in closed tanks or boilers without pressure. This is commonly known as the Open Tank or Non-Pressure Process.

(2) Impregnation by pneumatic pressure by means of force pumps and air-tight cylinders. This is commonly known as the Pressure Process.

The first method is the simplest and oldest form for applying a preservative. As its name indicates, it consists in dipping or steeping the wood in open tanks, filled with the preservative used. In some cases the wood is boiled in the preservative. Again, in some cases, the wood is placed in a closed cylinder and boiled, but no pressure is applied. It necessarily follows that this is an *absorption* rather than an injection of the preserving fluid. It also follows that the depth of penetration obtained is very shallow, except for particularly open or porous woods, such as sap pine.

There are only seventeen open tank or non-pressure plants worthy of mention in America, and some of these are hardly worth listing. For example, plant No. 10-a was built by the City of Cleveland only as an experiment, according to a report made by the City Engineer. He further states that the plant did not demonstrate any financial saving, as the city was able to buy treated timber at a lower cost than they could treat it themselves, and the tank was kept in operation for only a short period. On the Pacific Coast there are three or four small iron open tanks in which the butts of poles are boiled in Creosote Oil. In various parts of the country we find small open tanks, usually second-hand boilers or cylinders, with an opening cut along the upper side and place to kindle fire underneath. In these fence posts are boiled in the preservative.

However, the quantity of wood treated by the open tank and non-

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pressure process is comparatively insignificant, perhaps it does not exceed one per cent. of all the material treated in this country.

The second method of impregnation is the one in general use. In this case the timber is placed in cylinders with closed ends and the preservative is injected into the wood under a pressure by the use of a force pump. There are some variations in the operation, but the principle is the same in all of them, namely, the injection of the fluid by the application of pressure.

The various methods or processes employed in America may be classed in five groups and described as follows:

Process "A"—(Bethel—Burnett—Lowry).

Ties, piling, timbers, poles, paving blocks, etc., are first air seasoned (that is, piled in open air for a period of three to twenty months), then run into cylinders and doors closed. The wood is then submerged in the preservative fluid, heated to a temperature of 170 to 190 degrees Fahr. before admission into the cylinders. Pressure pump is put into action, forcing more fluid into the cylinder. The operation is continued and maintained until the desired absorption is obtained. The pressure is then released, the surplus fluid drained from the cylinder and a vacuum is applied. This last operation is for the purpose of hastening the drying of the material. This completes the treating operation, and the material is then withdrawn from the cylinders. The above-described method is known as the Bethell Process (Pat. 1838) when using creosote oil, Burnett Process (Pat. 1838) when using Cloride of Zinc or Lowry Process (Pat. 1906) using creosote oil.

Process "B"—(Preliminary Steaming—Vacuum—Pressure.)

Ties, piling, timbers, poles, paving blocks, etc., green or partially seasoned, are run into cylinders and doors closed. Live steam is admitted at such rate as to secure 20 pounds of steam pressure within thirty to fifty minutes. This pressure is maintained for periods varying from one to five hours, depending upon the character of the timber and its condition, but the pressure, as indcated on the gauge, should not exceed twenty pounds. A vacuum is then applied and maintained for at least one-half hour, at the expiration of which time the preservative is admitted into the cylinder without otherwise breaking the vacuum. The wood is then submerged in a preservative fluid, heated to a temperature of 170 to 190 degrees Fahr., before admission into the cylinder. Pressure pump is then put in action, and the remainder of the operation is the same as process "A," above described. This process is quite old and has no patent claimants.

Process "C"—(Boulton—Curtis and Isaacs—Buehler.)

Ties, piling, timbers, poles, paving blocks, etc., green or partially seasoned, are run into a cylinder and door closed. The wood is then sub-

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merged in a preservative fluid (usually Creosote Oil) and temperature raised to 215 to 225 degrees Fahr., and the boiling maintained for periods varying from four to eight hours, depending upon the character of the timber and its condition. A vacuum is sometimes applied to assist liberation of saps in the wood. Pressure pump is then put in action, and the remainder of the operation is substantially the same as process "A," above described. This method is called Boulton's Process (Pat. 1879), Curtis and Isaacs, (Pat. 1895), Buehler Process (Pat. 1908). This process is used extensively on the Pacific Coast for treatment of Douglas Fir.

Process "D"—(Rueping.)

Ties, piling, timbers, poles, paving blocks, etc., are first air seasoned, then run into a cylinder and door closed. An initial air pressure of varying intensity is applied, and without lowering this air pressure the cylinder is filled with a preservative (usually creosote oil) having a temperature of 170 to 190 degrees Fahr. Pressure pump is then put into action and the pressure raised still higher. The remainder of the operation is substantially the same as in process "A," above described. This method is known as the Reuping Process (Pat. 1902 and reissued in 1907). The patentees call it an "Empty cell" process. (*See foot note.*)

Process "E"—(Card.)

Creosote Oil and Zinc Chloride (a water solution) have different specific gravities, and therefore separate from each other unless kept in agitation. When it is desirable to use a mixture of these two preservatives for the treatment of wood, it is necessary to keep the solution in agitation in the treating cylinder while it is being forced into the wood. A device for this purpose has been invented and patented by Mr. Card. The emulsion of Zinc Chloride and Creosote Oil is made and forced into the wood in one operation. This is knwn as the Card Process (Pat. 1906).

Species of Wood Treated.

The varieties of wood treated are many, and depend to a large extent upon the kind of timber available in the locality of the treating plant. In order to facilitate replies the Association's circular letter of inquiry gave a list of woods in North America, as given below, to which we have prefixed an index number.

The reverse of this process is used at some treating plants; that is, instead of applying an initial air pressure, a preliminary vacuum is applied. The effect of this operation is to leave more of the fluid in the wood. Experiments described by Mr. Howard F. Weiss and published in the American Wood Preservers' Association proceedings, 1912, page 181. clearly indicate the effect of an initial air pressure or preliminary vacuum in wood upon its treatment.

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Northern Forest.

100	White Pine	105	Birches	110	Tamarack
101	Red Pine	106	Hemlocks	111	Maples
102	Jack Pine	107	Beech	112	Ashes
103	Spruces	108	Chestnut	113	Cedars
104	Balsam Fir	109	Poplars	114	Aspens

Central Forest.

115	White Oak	122	Yellow Poplar	129	Buckeyes
116	Black Oak	123	Cherry	130	Cottonwoods
117	Red Oak	124	Ashes	131	Black Gum
118	Hickories	125	Elms	132	Sycamores
119	Chestnut	126	Maples	133	Butternut
120	Walnut	127	Beech		
121	Linden	128	Locust		

Southern Forest.

134	Long Leaf Yellow Pine	139	Juniper	146	Butternut
		140	Ashes	147	White Cedar
135	Short Leaf Yellow Pine	141	White Oak	148	Elms
		142	Black Oak	149	Osage
136	Loblolly Pine	143	Cypress	150	Honey Locust
137	Red Oak	144	Black Gum		
138	Hickories	145	Red Gum		

Rocky Mountain Forest.

151	Yellow Pine	154	Douglas Fir	157	Balsam Fir
152	Spruces	155	Junipers	158	Aspens
153	Cottonwoods	156	Oaks		

Pacific Coast Forest.

159	Douglas Fir	163	Cottonwoods	169	Birches
160	Western Red Cedar	164	Spruces	170	Redwood
		165	Hemlocks	171	Cedars
161	Yellow Pines	166	White Pines	172	Larches
162	Balsam Fir	167	Junipers	173	Alders
		168	Maples		

Tropical Forest (Mexico).

174	Pines	177	Mesquite	181	Ash
175	Mulberry	178	Elm	182	Cottonwood
176	Linden	179	Sycamore	183	Mora
		180	Ceiba		

Most all species of wood in America are susceptible to treatment and the useful life of same can be greatly increased by proper treatments.

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Kind of Material Treated.

The chief item is railroad ties. perhaps constituting no less than ninety per cent. of all the wood treated in America; the remaining ten per cent. consists of several items. The Association's circular letter of inquiry gave a list of the principal kinds of material treated as shown below and to which an index number has been prefixed to to each item, as follows:

200	Railroad Ties	204	Switch Ties	209	Wooden Pipe
201	Piling	205	Cross Arms	210	Crossing Plank
202	Telegraph Poles	206	Mine Props	211	Signal Poles and
203	Dimension Timbers	207	Fence Posts	212	Tie Plugs
		208	Paving Blocks		

Capacity of Plants.

The capacity of a treating plant depends primarily upon the size and number of impregnating cylinders. There are four prime factors which affect the number of ties that can be treated with a given cylinder, namely:

(1) Length and size of ties.
(2) Whether steamed and impregnated in the same cylinder or in separate cylinders.
(3) Number of hours daily that the plant is in operation.
(4) Whether or not the plant is in continuous operation throughout all seasons of the year.

Ties vary in length, some containing as little as two and one-half cu. ft., while some contain as much as three and three-quarters cu. ft. of timber and it is obvious that the number of ties that can be loaded on a tram varies with their size, besides this, a given cylinder will not hold as many trams of ties 8½ feet long as it would ties 8′ long.

If ties are steamed and impregnated in the same cylinder (Process "B") obviously a less number of ties can be treated in a given cylinder. Let us suppose that the time required to steam the ties be an average of four hours and for simple impregnation (Process "A") four hours also, then it would be possible to treat only three charges of ties every twenty-four hours when steamed and impregnated or six charges if impregnated only.

If the plant is not operated continuously day and night (except Sundays) the number of ties treated would be proportionately less or in proportion to the number of hours the plant is in operation.

Finally, if the plant is closed down during the Winter months of the year, as is frequently necessary in Northern latitudes, the output is correspondingly decreased.

Other allowances have to be made for breakdowns and unexpected interruptions in the operation of the works.

In order to find the ratio between the cubical measurements of cylinders and their treating capacity, let us take two cylinders seven feet

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diameter, one hundred feet long and suppose that railroad ties are simply impregnated in the usual way (Process "A") the schedules would be as follows:

Daily run hours.	No. of charges.	No. of 6′ x 8 x 8′ ties.	No. of 7x8x8½ ties.
4	1	564	517
6	2	1128	1034
8	3	1692	1551
10	4	2256	2068
12	5	2820	2585
14	6	3384	3102
16	7	3948	3619
18	8	4512	4136
20	9	5076	4653
22	10	5640	5170
24	12	6768	6204

300 days 6768 8 ′ ties per day = 2,030,400 ties.
300 days 6204 8½′ ties per day= 1,861,200 ties.

If ties are given a preliminary steaming, (Process "B") the number treated annually would be reduced about half, as it takes about as many hours to steam them as it does to impregnate with the preservative.

In either case it would be very improbable that the maximum number of ties above stated could be treated annually and the amounts should be liberally reduced, just how much would depend on many factors, principally, the four above mentioned. In our opinion, the reduction should be on an average of about fifty per cent.; in other words, with two cylinders of size above mentioned, an average of 1,000,000 ties would be treated annually by Process "A". As these two cylinders have a volume of 7696 cu. feet, the ratio would be 130 ties per cubic foot of cylinder volume and this is the common factor which we have used in computing the capacity of treating plants given in the accompanying list. This factor may be increased or decreased and the author leaves it to the reader to assume whatever figure he pleases, but in doing so, it should be made applicable to all plants in estimating their relative capacities, for as above stated, the capacity of a treating plant depends primarily upon the size and number of cylinders.

Several plants contemplate enlarging their works by increasing the length or number of cylinders, but in the report we have given the capacity of plant, based on cylinders in actual operation. The report distinguishes those plants that do commercial work from those which treat for certain railroads exclusively. As a rule, plants owned and operated by railroad companies treat for their lines exclusively and do not handle any commercial work of any kind for outside parties.

Growth of the Industry.

In 1885 there were only five Pressure plants in operation in America.

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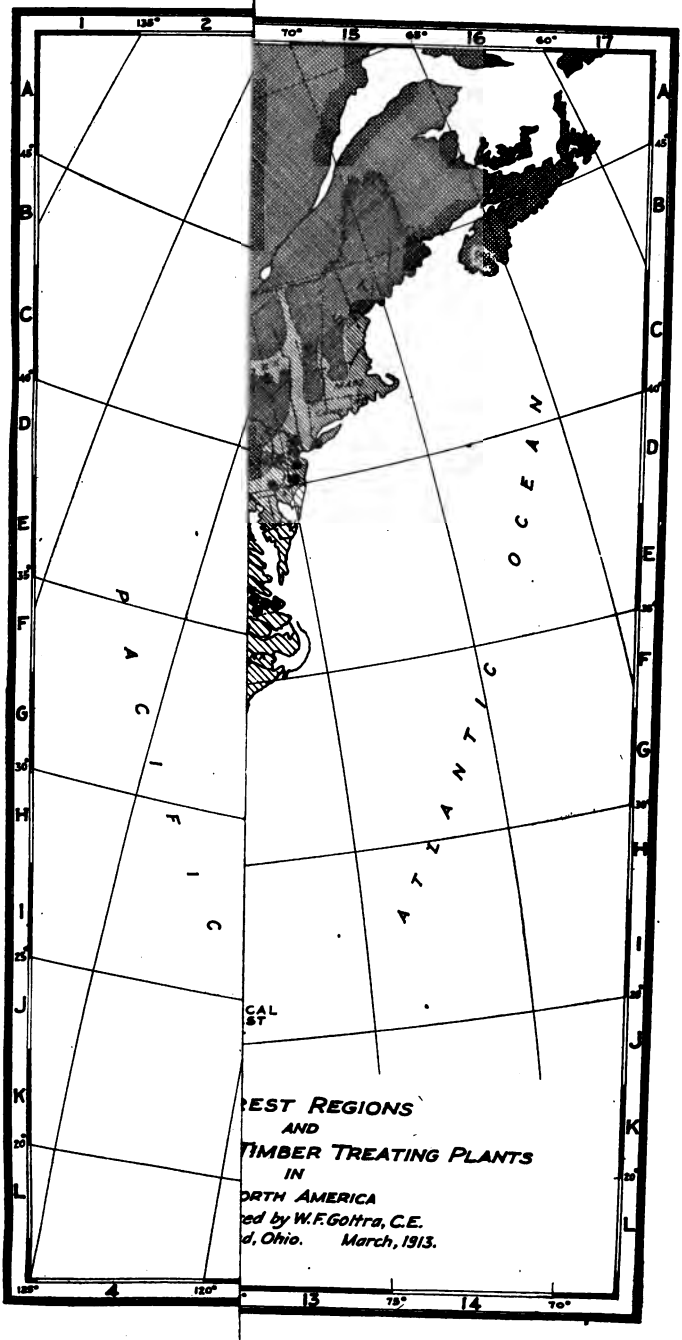

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The number gradually increased from year to year. In 1890 there were eight plants, in 1895, twelve plants, in 1900, fifteen plants, in 1905, thirty-four plants, in 1910, seventy-five plants and at the end of the year 1912, eighty-four plants in operation and six under construction. During the past twelve years the increase in number of plants in United States has been at the rate of six plants a year. There are four plants in Canada and two in Mexico.

At the end of the year 1903, there were twenty-seven plants in operation, with an aggregate capacity of 21,000,000 ties per annum, or its equivalent in timber and other material, while at the end of the year 1912 there were eighty-four plants in operation with an aggregate capacity of 97,904,000 ties per annum. Thus the number of plants was trebled and capacity quadrupled during the past nine years. This is a marvelous growth and there is every reason to believe that the industry will continue to grow from year to year until the bulk of the cross ties used in this country shall receive a preservative treatment.

The accompanying map shows the location of all the Pressure plants as well as the Forest Regions of North America. They seem numerous but there is room and need for more.

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LIST OF WOOD-PRESERVING PLANTS IN THE UNITED STATES, CANADA AND MEXICO, JANUARY 1st, 1913.

PRESSURE PROCESS.

EASTERN STATES.

Plant No. Reference.	Map Reference.	Location.	Managing Company.	Address.	Year built.	No. of Cylinders.	Dia., inches.	Length, ft.	Volume, cu. ft.	Capacity per an. 6 in. x 8 in. 8 ft. ties.
1	C14	Long Island City, N. Y.	Eppinger & Russell Co.	New York, N. Y.	1878	4	72	100	11,312	1,470,000
2	B14	Rome, N. Y.	Federal Creosoting Co.	Louisville, Ky.	1910	2	84	150	11,550	1,495,000
3	C14	Bound Brook, N. J.	Federal Creosoting Co.	Louisville, Ky.	1909	1	84	150	5,775	750,000
4	C14	Newark, N. J.	American Creosoting Co.	New York, N. Y.	1906	2	78	105	6,972	905,000
5	C14	Paterson, N. J.	Federal Creo. Co.	Louisville, Ky.	1909	1	84	150	5,775	750,000
6	C14	Maurer, N. J.	Barber Asphalt Pav. Co.	Maurer, N. J.	1905	4	72	115	13,008	1,690,000
7	C13	Port Reading, N. J.	P. & R. R. R., C. R. R. of N. J.	Port Reading, N. J.	1912	2	88	140	11,368	1,475,000
8	C13	Greenwich, Pa.	Penna. R. R.	Philadelphia, Pa.	1910	2	72	132	7,466	970,000
9	C13	Mt. Union, Pa.	Penna. R. R.	Philadelphia, Pa.	1909	1	72	132	3,733	485,000
10	C13	Broadford Jc., Pa.	Pittsburgh Wd. Pres. Co.	Pittsburgh, Pa.	1911	1	84	132	4.082	530,000
11	C13	Bradford, Pa.	Buff., Roch. & Pgh. R. R.	Rochester, N. Y.	1910	1	75	95	2,914	365,000
12	E13	Buell, near Norfolk, Va.	U. S. Wood Pres. Co.	New York, N. Y.	1907	2	78	150	9,960	1,295,000
13	E13	Buell, near Norfolk, Va.	Norfolk Creosoting Co.	Norfolk, Va.	1896	4	78	100		
						1	78	105		
					1905	1	84	125	21,578	2,800,000
14	E13	Norfolk, Va.	Atlantic Creo. & Wood Preserving Works.	Norfolk, Va.		1	78	62		
						1	78	82		
					1901	1	78	126	8,964	1,165,000
15	E13	Portsmouth, Va.	Wyckoff Pipe & Creo. Co.	50 Church St., New York	1881	4	74	102	13,000	1,690,000
16	D13	Green Spring, W. Va.	Balto. & Ohio. R. R.	Baltimore, Md.	1912	2	84	132	10,198	1,325,000

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Plant No. Reference.	Map Reference.	Location.	Managing Company.	Address.	Year built.	No. of Cylinders.	Dia., inches.	Length, ft.	Volume, cu. ft.	Capacity per an. 6 in. x 8 in. 8 ft. ties.
17	H12	Gainesville, Fla.	Atlantic Coast Line R. R.	Wilmington, N. C.	1912	2	74	138	8,252	1,070,000
18	G11	Pensacola, Fla.	Southern Pav. Con. Co.	Chattanooga, Tenn.	1912	1	72	90	2,545	330,000
19	G12	Jacksonville, Fla.	Eppinger & Russell Co.	New York, 168 Broadway	1909	3	84	130	15,015	1,950,000
20	I12	Hull, Fla.	Charlotte Harbor and Nor. Ry. Co.	Boca Grande, Fla.	1912	1	74	73	2,182	285,000
21	F12	Macon, Ga.	Central of Ga. R. R. Co.	Macon, Ga.	1912	2	84	116	8,932	1,160,000
22	F12	Atlanta, Ga.	Southern Wd. Pres. Co.	Atlanta, Ga.	1908	1	72	70	1,960	255,000
23	F12	Ensley, Ala.	Pioneer Lum. & Creo. Co.	Ensley, Ala.	1911	1	74	76	2,272	295,000
24	G11	Mobile, Ala.	Republic Creosoting Co.	Indianapolis, Ind.	1906	2	74	130	7,774	1,010,000
25	F11	McAdory, Ala.	Tennessee Coal, Iron and Railroad Co.	Birmingham, Ala.	1909	1	72	65	1,838	240,000
26	H10	Southport, near New Orleans, La.	American Creosote Wks.	New Orleans, La.	1901	1	84	172	17,557	2,275,000
27	H10	New Orleans, La.	New Orleans Wd. Pr. Co.	River & Lyon Sts., New Orleans, La.	1888	1	72	125	3,535	460,000
28	G11	Slidell, La.	Southern Creosoting Co.	Slidell, La.	1879	1	84	150	11,431	1,480,000
29	G10	Shreveport, La.	Shreveport Creo. Co.	Amer. Creo. Co., Louisville, Ky.	1902	2	72	100	10,318	1,340,000
30	G10	Winnfield, La.	Louisiana Creo. Co.	Winnfield, La.	1910	2	84	134	5,825	755,000
31	G11	Bogalusa, La.	Colonial Creo. Co.	American Creo. Co., Louisville, Ky.	1906	1	72	126	7,578	985,000
32	F11	Grenada, Miss.	Ayer & Lord Tie Co.	Chicago, Ill.	1912	1	72	80	15,308	1,990,000
					1912	2	72	134		
					1904	4	74	128		

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SOUTHERN STATES.

Plant No. Reference.	Map Reference.	Location.	Managing Company.	Address.	Year built.	No. of Cylinders.	Dia., inches.	Length, ft.	Volume, cu. ft.	Capacity per an. 6 in. x 8 in. 8 ft. ties.
33	G11	Gulfport, Miss.	Gulfport Creo. Co.	Gulfport, Miss.	1906	2	84	120	9,240	1,210,000
34	G11	Gautier, Miss.	W. Pascagoula Creo. Wks	L. & N. R. R., Louisville, Ky.	1876	1	72	119		
					1903	2	72	115	9,870	1,285,000
35	F11	Louisville, Miss.	American Creo. Wks.	New Orleans, La.	1912	1	108	172	10,939	1,415,000
36	F10	Argenta, Ark.	Ayer & Lord Tie Co.	Chicago, Ill.	1907	4	74	132	15,788	2,050,000
37	F10	Texarkana, Ark.	Int. Creo. & Con. Co.	Galveston, Tex.		1	114	165		
					1902	1	72	125	15,230	1,975,000
38	G10	Beaumont, Tex.	Int. Creo. & Con. Co.	Galveston, Tex.	1892					
					1897	1	108	140	8,905	1,155,000
39	F9	Denison, Tex.	Mo. Kan & Tex. Ry. Co. of Texas.	St. Louis, Mo.	1909	4	72	108	12,216	1,585,000
40	F10	Texarkana, Tex.	Nat. Lum. & Creo. Co.	Texarkana, Ark.	1910	2	84	132	10,164	1,320,000
41	H9	Houston, Tex.	Nat. Lum. & Creo. Co.	Texarkana, Ark.	1912	4	72	120	13,574	1,765,000
42	H9	Houston, Tex.	Tex. & N. O. R. R. Co.	Houston, Tex.	1890	5	72	112	15,835	2,055,000
43	G9	Somerville, Tex.	A., T. & S. F. R. R.	Topeka, Kan.	1906	5	74	132	19,734	2,560,000
44	F9	Hugo, Okla.	American Creo. Co.	Louisville, Ky.	1907	2	84	134	10,318	1,340,000

CENTRAL STATES.

45	C12	Toledo Ohio.	Federal Creo. Co.	Louisville, Ky.	1909	3	84	134	15,477	2,000,000
46	C12	Toledo Ohio.	Jennison-Wright Co.	Toledo, Ohio.	1910	2	72	130	7,352	955,000
47	C12	Orrville, Ohio.	Ohio Wood Pres. Co.	Pittsburgh, Pa.	1912	1	84	132	5,080	660,000
48	D12	Cincinnati, Ohio.	Comp. Wd. Pres. Co.	Cincinnati, Ohio.	1909	1	72	76	2,150	280,000

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Plant No. Reference.	Map Reference.	Location.	Managing Company.	Address.	Year built.	No. of Cylinders.	Length, ft.	Dia., inches.	Volume, cu. ft.	Capacity per an. 6 in. x 8 in. 8 ft. ties.
49	D11	Indianapolis, Ind.	Republic Creo. Co.	Indianapolis, Ind.	1903	1	74	130	3,887	505,000
50	D11	Shirley, Ind.	American Creo. Co.	Louisville, Ky.	1905	2	84	134	10,318	1,340,000
51	D11	Terre Haute, Ind.	Indiana Zinc-Creo. Co.	Terre Haute, Ind.	1904	2	72	120	6,787	880,000
52	D11	Terre Haute, Ind.	Chicago Creosoting Co.	Chicago, Ill.	1912	2	132	20	3,800	485,000
53	D11	Bloomington, Ind.	Indiana Creosoting Co.	Louisville, Ky.	1907	1	84	134	5,159	670,000
54	D11	Columbus, Ind.	Indianapolis, Columbus & Southern Trac. Co.	Indianapolis, Ind.	1909	1	72	45	1,272	165,000
55	D11	Evansville, Ind.	Indiana Tie Co.	Evansville, Ind.	1907	2	72	110	6,220	810,000
56	C11	Waukegan, Ill.	Chicago Creosoting Co.	Chicago, Ill.	1907	2	72	134	7,578	985,000
57	D11	Carbondale, Ill.	Ayer & Lord Tie Co.	Chicago, Ill.	1902	4	72	122	29,587	3,850,000
58	D11	Marion, Ill.	American Creo. Co.	Louisville, Ky.	1907	2	84	134	10,318	1,340,000
59	D10	Madison, Ill.	Kettle River Co.	Minneapolis, Minn.	1909	4	84	135	20,790	2,700,000
60	C10	Galesburg, Ill.	C., B. & Q. R. R.	Galesburg, Ill.	1907	5	74	132	19,734	2,560,000
61	D11	Mt Vernon, Ill.	T. J. Moss Tie Co.	St. Louis, Mo.	1899	1	74	132	7,255	940,000
62	E11	Joppa, Ill.	Indiana Tie Co.	Evansville, Ind.	1909	2	72	110	6,220	810,000
63	B12	Bay City, Mich.	Michigan Pipe Co.	Bay City, Mich.	1893	1	72	42	1,188	155,000
64	A11	Escanaba, Mich.	Chi. & N. W. Ry. Co.	Chicago, Ill.	1903	3	72	112	9,472	1,230,000

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CENTRAL STATES.

Plant No. Reference.	Reference. Map	Location.	Managing Company.	Address.	Year built.	No. of Cylinders	Length, ft.	Dia., inches.	Volume, cu. ft.	Capacity per an. 6 in. x 8 in. 8 ft. ties
65	A10	Minneapolis, Minn.	Republic Creosoting Co.	Minneapolis, Minn.	1905	2	74	130	7,774	1,010,000
66	A10	Sandstone, Minn.	Kettle River Co.	Minneapolis, Minn.	1904	2	72	120	6,787	880,000
67	A10	Brainerd, Minn.	Nor Pac. Ry.	St. Paul, Minn.	1907	2	84	134	10,318	1,340,000
68	E10	Springfield, Mo.	American Creo. Co.	Louisville, Ky.	1907	2	84	134	10,318	1,340,000
69	D10	Kansas City, Mo.	American Creo. Co.	Louisville, Ky.	1907	2	84	134	10,318	1,340,000
70	D9	Topeka, Kansas.	Union Pacific R. R.	Omaha, Neb.	1909	2	73	117	6,800	885,000

ROCKY MOUNTAIN AND PACIFIC STATES.

71	A6	Somers, Mont.	Great Nor. Ry. Co.	St. Paul, Minn.	1901	4	72	110	12,442	1,610,000
72	A6	Paradise, Mont.	Nor. Pac. Ry. Co.	St. Paul, Minn.	1907	2	84	134	10,318	1,340,000
73	A6	Butte, Mont.	Anaconda Cop. Min. Co.	Butte, Mont.	1910	1	72	43	1,216	160,000
74	B7	Sheridan, Wyo.	C., B. & Q. R. R. Co.	Chicago, Ill.	1899	2	74	132	7,894	1,025,000
75	C7	Laramie, Wyo.	Union Pacific R. R. Co.	Omaha, Neb.	1903	2	73	117	6,800	885,000
76	A5	Kellogg, Idaho.	Bunker Hill and Sullivan Mining Co.	Kellogg, Idaho.	1908	1	84	10	385	50,000
77	A4	Tacoma, Wash.	S.t P. & Tacoma Lum. (	Tacoma, Wash.	1912	1	84	130	5,005	650,000
78	A4	Yardley, Wash.	Western Wd. Pres. Co.	615 Peyton Bldg, Spokane, Wash.	1912	1	84	65	2,502	325,000
79	A4	Lowell, Wash.	Puget Sd. Wd. Pres. Co.	Lowell, Wash.		1	84	117		
						1	72	83		
					1895	1	72	52	8,322	1,080,000
80	A4	Seattle, Wash.	J. M. Colman Co.	Seattle, Wash.	1884 1912	3	75	120	11,043	1,430,000

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ROCKY MOUNTAIN AND PACIFIC STATES.

Plant No. Reference.	Map Reference.	Location.	Managing Company.	Address.	Year built.	No. of Cylinders	Length, ft.	Dia., inches.	Volume, cu. ft.	Capacity per an. 6 in. x 8 in. 8 ft. Ties.
81	A4	Eagle Harbor, Wash.	Pacific Creosoting Co.	Eagle Harbor, Wash.	1906	8	73	125	29,060	3,770,000
82	A4	Wyeth, Ore.	Oregon-Washington R. R. and Nav. Co.	Portland, Ore.	1904	4	72	114	12,995	1,690,000
83	A4	St. Helens, Ore.	St. Helens Creo. Co.	St. Helens, Ore.	1912	2	84	136	10,472	1,360,000
84	B4	Latham, Ore.	Southern Pac. R. R.	San Francisco, Cal.	1893	2	72	112	6,334	825,000
85	A4	Burlington (near Portland), Ore.	Columbia Creo. Co.	809 Lewis Bldg., Portland, Ore.	1912	1	72	65	1,838	240,000
86	F7	Alamogordo, N. Mex.	El Paso & S. W. R. R. Co	El Paso, Tex.	1902	2	72	106	5,995	780,000
87	E7	Albuquerque, N. M.	A. T. & S. F. Ry. Co.	Topeka, Kansas.	1908	2	74	132	7,894	1,025,000
88	D4	Oakland, Cal.	So. Pacific Ry.	San Francisco, Cal.	1889	1	72	108	6,956	900,000
89	F5	Los Angeles, Cal.	So. Pacific Ry.	San Francisco, Cal.	1907	2	72	112	6,334	825,000
90	F5	San Pedro, Cal.	S. P. L. A. & S. L. R. R.	Los Angeles, Cal.	1908	2	72	117	6,617	860,000
					Grand Total.....					103,369,000

CANADA.

91	A11	St. Francis, Ont.	Alex. Bruce & Co.	Glasgow, Scotland.	1912	1				
92	A9	Transcona, near Winnipeg, Man.	Dominion Tar and Chem. Co., Ltd.	Sydney, N. S.	1912	1 3	78 78	84 135	16,225	2,110,000
93	A16	Sydney, N. S.	Dominion Tar and Chem. Co., Ltd.	Sydney, N. S.	1911	1				
94	A4	Vancouver, B. C.	Dominion Creo. Co.	Vancouver, B. C.	1910	2				

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Plant No Reference.	Map Reference.	Kinds of Wood Treated.	Kind of Material Treated	Preservative Used.	Plant equipped to treat by process.	Commercial Works.	Remarks.
1	C14	103 108 115 119 134 135 136	200 201 202 203 204 205 210	Creosote	A	Yes	
2	B14	105 107 111 116 117 126 127 134 135 136	200 204	Creosote	A	No	
3	C14	116 117 134 135 136	200 201 203 204	Creosote	A	Yes	
4	C14	134 135 136	200 201 203 204	Creosote	A	Yes	
5	C14	115 116 117 119 127 134 135 136	200 201 203 204 210	Creosote	A	No	
6	C14	100 103 106 115 116 117 134 135 136 159	200 201 202 203 204 205 207 208 210	Creosote Water Gas Tar	A and B	Yes	
7	C13	115 116 117 118 122 124 125 126 127 132 134 135 136 137 138 140 141 142 144 148	200 201 203 204	Creosote	A	No	
8	C13	105 107 111 116 117 126 127 131 134 135 136 144	200 201 202 203 204 205 207 208 209 210 211	Creosote	A and D	No	
9	C13	105 107 111 117 126 127 134 135 136	200 201 202 203 204 205 207 208 209 210 211	Creosote	A and D	No	
10	C13	115 116 117 118 119 125 126 127 132	200 201 204 208 210	Creosote Chl. Zinc	A, D and E	Yes	
11	C13	105 116 117 118 119 123 125 126 127 131	200 204 210 212	Creosote	A	No	

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EASTERN STATES

Plant No Reference.	Map Reference	Kinds of Wood Treated.	Kind of Material Treated	Preservative Used.	Plant equipped to treat by process.	Commercial Works.	Remarks.
12	E13	131 134 135 136 144	208	Creosote	A	Yes	Treat Paving Blocks
13	E13	131 134 135 136 137 139 141 144	200 201 202 203 204 205 207 209 210	Creosote	A and B	Yes	
14	E13	134 135 136 137 144 145	200 201 202 203 204 205 207 209 210	Creosote	A and B	Yes	
15	E13	134 135 136	200 201 202 203 204 205 207 208 209 210	Creosote	A	Yes	
16	D13	116 117 124 125 126 127 133 137 142	200 204	Creosote Chl. of Zinc	A, B and E	No	Under construction.

SOUTHERN STATES.

17	H12	134 135 136	200	Creosote	A	No	
18	G11	134 135 136	200 201 202 203 204 205 206 207 208 210	Creosote	A	Yes	
19	G12	134 135 136	200 201 202 203 204 205 207 208 210	Creosote	A	Yes	
20	G12	134 135 136 143	200 201 203 204 207 210	Creosote	A and D	Yes	Under construction.
21	G12	121 134 135 136 144	200 201 202 203 204 210	Creosote Chl of Zinc	A and D	No	
22	F12	117 134 135 136 137	200 202 203 204 205 207 208	Creosote	A	Yes	

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Plant No. Reference	Map Reference	Kind of Wood Treated	Kind of Material Treated	Preservative Used	Plant equipped to treat by process	Commercial Works	Remarks
23	F11	134 135 136	200 201 202 203 204 207 208	Creosote	A	Yes	
24	G11	134 135 136 137 141 142 144	200 201 202 203 204 205 206 207 208 210	Creosote	A	Yes	
25	F11	134 135 136	200 202 203 207	Creosote	A	No	
26	H10	134 135 136 137 144 145	200 201 202 203 204 205 207 208 210	Creosote	A and D	Yes	
27	H10	134 135 136	200 201 202 203 204 205 207	Creosote	A and D	Yes	
28	G11	134 135 136 143	200 201 202 203 204 205 206 207 208 209 210	Creosote	A and B	Yes	
29	G10	134 135 136 137 142	200 201 202 203 204 210	Creosote	A	Yes	
30	G10	134 135 136 137 145	200 201 202 203 205	Creosote	A and B	Yes	
31	G11	134 135 136 137 142	200 201 203 204 210	Creosote	A	Yes	
32	J11	134 135 136 137 143 144	200 201 202 203 204 207 208 210	Chl. of Zinc Creosote	A, B and D	Yes	
33	G11	134 135 136	200 201 202 203 204 205 207 208 210	Creosote	A, B and D	Yes	
34	G11	134 135 136	201 202 203 204 205 207 208 209	Creosote	A and B	No	

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SOUTHERN STATES

Plant Reference	Map Reference	Kinds of Wood Treated	Kind of Material Treated	Preservative Used	Plant equipped to treat by process	Commercial Works	Remarks
35	F11	134 135 136 137 144 145	200 201 202 203 204 205 207 208 210	Creosote	A and D	Yes	Under construction.
36	F10	116 117 124 125 127 128 131 134 135 136 137 140 142 144	200 201 202 203 204 208 210	Creosote Chl. of Zinc	A, B and D	Yes	
37	F10	134 135 136 137	200 201 202 203 204 205 206 207 208 210	Creosote Chl. of Zinc	A and B	Yes	
38	G10	134 135 136 137	200 201 202 203 204 205 206 207 208 210	Creosote Chl. of Zinc	A and B	Yes	
39	F9	123 130 134 135 136 140 141 142 143 144 145 146 147 148 150 153	200 201 203 204 205 207 210	Creosote	A and D	No	
40	F10	116 117 134 135 136 137 142 144 145	200 201 202 203 204 207 208 210	Creosote Chl. of Zinc	A, B, D & E	Yes	
41	H9	134 135 136 137 142 144 145	200 201 202 203 204 205 207 208 210	Creosote Chl. of Zinc	A, B and D	Yes	
42	H9	134 135 136	200 201 203 204 211	Creosote Chl. of Zinc	A and B	No	
43	G9	115 117 125 131 132 134 135 136 137 141 144 145 148	200 201 203 204 210	Creosote	A and D	No	
44	F9	134 135 136 137 138 142 144 145 148	200 201 203 204	Creosote	A	No	

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CENTRAL STATES.

Plant No. Reference	Map Reference	Kinds of Wood Treated.	Kind of Material Treated	Preservative Used.	Plant equipped to treat by process.	Commercial Works.	Remarks.
45	C12	105 116 117 124 125 126 127	200 201 203 204 210	Creosote	A	No	
46	C12	102 105 106 107 109 110 111 112 113 116 117 118 120 124 125 126 127 128 131 134 135 136	200 201 202 203 204 205 207 208 210	Creosote Chl. of Zinc	A and B	Yes	
47	C12	115 116 117 118 119 125 126 127 132	200 204	Creosote Chl. of Zinc	A. D and E	Yes	
48	D12	115 116 117 127 134 135 136 141 142	200 203 204 208	Creosote Crude Oil	A	Yes	
49	D11	134 135 136 137 141	200 203 204 205 207 208 210	Creosote	A	Yes	
50	D11	116 117 118 124 125 126 127 131 132	200 201 203 204	Creosote	A	No	
51	D11	116 117 125 126 127 134 135 136 159	200 201 203 204 205	Creosote Chl. of Zinc	A, B and E	Yes	
52	D11	134 135 136 208	208	Chl. of Zinc Creosote	A	Yes	Under construction For paving blocks only
53	D11	116 117 118 119 124 125 126 127	200 201 202 203 204 208 210	Creosote	A	Yes	
54	D11	116 117 118 119 121 122 123 124 126 127 131 132 133	200 202 203 204 205 207 210 200	Creosote	A	No	
55	D11	116 117 118 122 124 125 126 127 131 132 133 144	200	Chl. of Zinc Creosote	A and B	Yes	

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Plant Reference	Map Reference	Kinds of Wood Treated	Kind of Material Treated	Preservative Used	Plant equipped to treat by process	Commercial Works	Remarks
56	C11	106 107 110 111 117 126 127 134 135 136 137	200 201 203 204 208	Creosote Chl. of Zinc	A, B and C	Yes	
57	D11	115 116 117 118 119 124 125 127 131 132	200	Creosote Chl. of Zinc	A, B and D	Yes	
58	D11	127 134 135 136 137 142 144 145 148	200 201 202 203 204 208 210	Creosote	A	Yes	
59	D10	116 117 119 125 126 127 128 132 133 134 135 136 137 142 143 154 157 159	200 201 202 203 204 205 206 207 208 209 210	Creosote Chl. of Zinc	A, B, C & E	Yes	
60	C10	105 106 107 110 111 112 116 117 118 119 120 122 123 124 125 126 127 129 130 131 132 133 134 135 136 137 138 140 142 143 144 148 159	200 201 203 204 208 209 210	Creosote Chl. of Zinc	A, B and E	No	
61	D11	116 117 118 124 125 126 127 131 134 135 136	200 201 204	Creosote Chl. of Zinc	A, B and E	Yes	
62	E11	116 117 118 122 124 125 126 127 131 132 133 144	200	Creosote Chl. of Zinc	A and B	Yes	
63	B12	101 102 105 106 107 110 111	203 210	Creosote	A	Yes	
64	A11	105 106 107 110 111	200 201 203 204	Creosote Chl. of Zinc	A, B and E	No	

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CENTRAL STATES.

Plant Reference	Map Reference	Kinds of Wood Treated	Kind of Material Treated	Preservative Used	Plant equipped to treat by process	Commercial Works	Remarks
65	A10	100 101 102 103 106 110 111 113 134 135 136 154 159 160 172	200 201 202 203 204 207 208 210	Creosote	A	Yes	
66	A10	100 101 102 103 104 105 107 110 111	200 201 204	Creosote Chl. of Zinc	A, B and C	Yes	
67	A10	102 105 110 111 116 117	200 203 204 208 212	Creosote	A	No	
68	E10	116 117 124 125 126 127 134 135 136 145	200 201 203 204	Creosote	A	No	
69	D10	116 117 125 127 134 135 136	200 201 203 204	Creosote	A	No.	
70	D9	116 117 125 127 134 135 136	200 201 203 204	Chl. of Zinc	A and B	No	

ROCKY MOUNTAIN AND PACIFIC STATES.

71	A6	100 103 110 151 152 154 159 161 166 172	200 203 204 208	Chl. of Zinc	A and B	No	
72	A6	151 154 157 165 172	200 203 212	Creosote	A	No	
73	A6	151 154 159	200 204 206	Creosote	A	No	
74	B7	102 103 106 110 159	200	Chl. of Zinc	A and B	No	
75	C7	102 103 106 110 159	200	Chl. of Zinc	A and B	No	
76	A5	159 160 161 162	206	Creosote	A	No	

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ROCKY MOUNTAIN AND PACIFIC STATES.

Plant No Reference	Map Reference.	Kinds of Wood Treated.	Kind of Material Treated	Preservative Used.	Plant equipped to treat by process.	Commercial Works.	Remarks.
77	A4	159 171	200 201 202 203 204 205 206 207 208	Creosote	A and C	Yes	
78	A4	159 161 162	200 201 202 203 204 210	Creosote	A	Yes	Under construction.
79	A4	159 161 165 166 171	200 201 202 203 204 205 208 210	Creosote	A, B and C	Yes	
80	A4	159	200 201 203 204 208 210	Creosote	A and B	Yes	
81	A4	159	200 201 203 204 205 207 208 209 210	Creosote	A and C	Yes	
82	A4	159	200 201 203 204 208	Creosote Chl. of Zinc	A and C	No	
83	A4	159	200 201 202 203 204 210	Creosote	A and C	Yes	Under construction.
84	B4	159	200 201 202 203 204 208	Creosote Chl. of Zinc	A, B and C	No	
85	A4	159 165	200 204 205 207 208 209 210	Creosote	A, B and C	Yes	Under construction.
86	F7	101 151 154	200	Creosote	A and D	No	
87	E7	151 152 154 157	200 201 203 204 210	Crude Oil Creosote	A and C	No	
88	D4	159	200 201 203 204 205 208 209 210	Creosote Chl. of Zinc	A, B and C	No	
89	F5	159	200 204	Chl. of Zinc	A and B	No	
90	F5	159	200 201 203 204	Creosote Chl. of Zinc	A, B and C	Yes	

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CANADA.

Plant No. Reference	Map Reference	Kinds of Wood Treated	Kind of Material Treated	Preservative Used	Plant equipped to treat by process	Commercial Works	Remarks
91	A11	101 102 103 104 105 106 107 108 110 111 112	200 201 203 204 210	Chl. of Zinc	A and B	Yes	
92	A9	101 102 103 104 105 106 107 108 110 111 112	200 201 203 204 210	Creosote	A and B	Yes	
93	A16	101 102 103 104 105 106 107 108 110 111 112	200 201 203 204 210	Creosote	A and B	Yes	
94	A4	159 160 161 162	200 201 202 204 210	Creosote	A, B and C	Yes	

MEXICO.

Have no data regarding treating plants in Mexico. The Mexican Central Railroad built a plant at Aguas Calientas, Mexico (K8) in 1901 to treat railroad ties with chloride of zinc. About the year 1907 the Madero Company built a two-cylinder plant at Maderoa, Chihuahua, Mexico (H7) to treat railroad ties with chloride of zinc.

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OPEN TANK OR NON-PRESSURE PROCESS PLANTS.

Plant No. Reference.	Location.	Managing Company.	Address.	Year built.	No. of tanks or boilers.	Size.	Capacity 6x8x8 ft. ties.
1a	Lowell, Mass.	Otis Allen & Son.	Lowell, Mass.	1848	2	4 ft. x 8 ft. x 50 ft.	30,000
2a	Portsmouth, N. H.	Otis Allen & Son.	Lowell, Mass.	1875	4	4 ft. x 8 ft. x 50 ft.	40,000
3a	Nanticoke, Pa.	Del, Lack & West. R. R. Coal Mining Dept.	Scranton, Pa.	1907	1	6 ft. dia. x 32 ft.	100,000
4a	New Philadelphia, Pa.	Phila. and Reading Coal and Iron Co.	Pottsville, Pa.	1908	1	6 ft. dia. x 32 ft.	100,000
5a	New Orleans, La.	Reeves Co.	New Orleans, La.	1910	1	4 ft. x 4 ft. x 30 ft.	20,000
6a	Keokuk, Iowa.	U. S. Wood Pres. Plant.	Keokuk, Iowa.	1908	1	4 ft. x 3 ft. x 42 ft.	25,000
7a	Milan, Ill.	U. S. Wood Pres. Plant.	Milan, Ill.	1908	1	4 ft. x 3 ft. x 42 ft.	25,000
8a	Stillwater, Minn.	U. S. Wood Pres. Plant.	Stillwater, Minn.	1908	1	4 ft. x 3 ft. x 42 ft.	25,000
9a	Fountain City, Wis.	U. S. Wood Pres. Plant.	Fountain City, Wis.	1908	1	4 ft. x 3 ft. x 42 ft.	25,000
10a	Cleveland, Ohio.	City of Cleveland.	Cleveland, Ohio.	1909	1	4 ft. x 3½ ft. x 42 ft.	25,000
11a	Lead, S. Dak.	Homestake Mining Co.	Lead, S. Dak.	1908	1	4 ft. dia. x 38 ft.	50,000
12a	Portland, Ore.	Carbolineum W. P. Co.	Portland, Ore.	1910	1	3 ft. x 4 ft. x 60 ft.	30,000
13a	Lowell, Wash.	Puget Sound W. P. Co.	Lowell, Wash.	1895	2	6 ft. x 10 ft. x 36 ft.	50,000
14a	Butte, Mont.	Anaconda Cop. Min. Co.	Butte, Mont.	1909	1	10 ft. x 10 ft. x 10 ft.	25,000
15a	Fresno, Cal.	San Joaquin Light and Power Co.	Fresno, Cal.	1910	2	7 ft. x 9 ft. x 9 ft.	50,000
16a	San Miguel, Cal.	San Joaquin Light and Power Co.	Fresno, Cal.	1910	1	7 ft. x 9 ft. x 9 ft.	25,000
17a	Oakland, Cal.	So. Pac. Ry. Co.	San Francisco, Cal.	1889	1	4 ft. x 6 ft. x 8 ft.	20,000
						Grand Total.....	665,000

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OPEN TANK OR NON-PRESSURE PROCESS PLANTS.

Plant Reference	Kinds of Wood Treated	Kind of Material Treated	Preservative Used	Process	Commercial Works	Remarks
1a	101 102 103 106 107 108 110	200 201 203 207 210	Chloride of Mercury	Immersion	Yes	
2a	101 102 103 106 107 108 110	200 201 203 207 210	Chloride of Mercury	Immersion	Yes	
3a	100 102 103 106 108 134 135 136	200 202 203 204 205 206 207 208	Creosote	Boiling	No	
4a	134 135 136	206	Chl. of Zinc Creosote	Boiling	No	
5a	134 135 136	200	Creosote	Boiling	No	
6a	134 135 136 143 144	204	Creosote	Immersion	No	
7a	134 135 136 143 159	204	Creosote	Immersion	No	
8a	134 135 136 143 159	204	Creosote	Immersion	No	
9a	134 135 136 143 159	204	Carbolineum	Boiling	No	
10a	134 135 136	204 208 210				
11a	151	200 201 203 205 210	Creosote	Boiling	No	
12a	159	200 202 203 208 210	Carbolineum	Boiling	Yes	
13a	159	202	Creosote	Boiling	Yes	For poles only.
14a	159	202	Creosote	Boiling	No	For poles only.
15a	160 161	203	Creosote	Boiling	No	For butts of poles only
16a	160 161	203	Creosote	Boiling	No	For butts of poles only
17a	159 170 171	203	Creosote	Boiling	No	For butts of poles only

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THE PRELIMINARY TREATMENT OF TIMBER TO INSURE A MORE EVEN AND SATISFACTORY IMPREGNATION WITH CREOSOTE.

By David Allerton.

I will premise by stating that my title does not exactly state what I have in mind. I cudgelled my brains, but could not arrive at anything better in the limited time at my command, which is only a few hours. I must also say that what I may suggest does not conflict with any existing method or process. It was brought forcibly to my attention last spring, although it has long been a subject of study with me—that is, to find a method by which the great disparity often noticed, and in fact usually observed, of the great difference in the receptivity of various ties or timbers in a given charge. Mr. Goltra, in his work, has shown graphically the various degrees of absorption in a charge of ties as usually treated; of course there will always, under any condition, be a considerable variation in a charge of carefully selected and sound ties and the same where structural timbers are treated, but is there not possible some method of preliminary treatment by which, without impairing the strength of the wood, the structure of the ties or timbers can be rendered more homogenous, so that with a given amount of oil the penetration will be more uniform? I assume that wood of the same species or variety, where the difference in penetration is marked, often as we have all observed in different parts of the same piece, that portion or piece which takes the oil readily would not be changed in its quality of absorption, but that the more difficult structure could be rendered more susceptible to impregnation, assuming, for instance, in the case of ties with a given quantity of oil—say the usual amount, 2½ or 3 gallons per tie—much more even penetration.

Of course, heat is a necessity in any mode of procedure, and the proper temperature and regulation will undoubtedly be the most important factor in solving this problem, as it is well known that to get good results from hot oil with cold wood is impossible (bear in mind I am not speaking of soft pine or other soft woods that take treatment under any conditions). But here arises another question. Suppose the oil is dropped on the cold wood at a temperature of 180°F. and the heat in the cylinder again raised to 180°, how far into that wood is the temperature 180 degrees. That, of course, depends on the diameter of the pieces. With large dimension timbers it is a very little ways, unless a long time has been consumed, and even then the center of the wood is very much cooler than the outside. This is one reason why large timbers such as 12 inch by 12 inch, or 12 inch by 14 inch, are very hard to treat. Taking this into consideration, I think the next most important

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factor will be air in conjunction with the heat in current, or compressed moist or dry, and perhaps attenuated by more or less vacuum, as the situation will be found to demand, and in all probability the process will be varied somewhat for different species.

I assume that all will agree that the better seasoned the great majority of wood is the easier and more satisfactorily it can be treated, therefore I also assume that a preliminary treatment can be found, and very likely some of you have discovered the means by which, with the necessary adjuncts to the treating cylinder, or in accessory and less expensive cylinders, by use of which valuable time can be saved and the wood can be prepared to accomplish the best results.

I trust that I have presented the case so that it will be understood, and I regret that the very limited time at my disposal will not permit me to go into the subject at length, as I would like to do, but I reflect that there are others probably better informed on this subject than I am, and I hope that facts of value will be brought out as this question is submitted to discussion, or that it may form a subject for future papers.

I will close with a quotation, after the fashion of my friend Burkhalter, but not from Hobbs, but from old Isaak Walton: "What is writ, is writ; would it were worthier."

Comments on Mr. Allerton's Paper.

MR. W. F. GOLTRA (written): Referring to Mr. Allerton's paper on "The Preliminary Treatment of Timber to Insure a More Even and Satisfactory Impregnation with Creosote," I desire to make some comments in writing.

Mr. Allerton states that the title of his paper does not exactly state what he has in mind, and from what follows I would imagine the title should read, "The Preliminary Treatment of Timber to Secure a More Thorough Impregnation with Antiseptics." It is just as important that the timber shall be properly seasoned when treated with zinc chloride or any other substance, as it is with creosote oil.

Preliminary treatment or seasoning, prior to injection of the antiseptics into the wood, is the most essential factor in the process of treating wood. Timber may be prepared for injection of the antiseptics in three ways:

(1) Open Air Seasoning, which is the common practice.
(2) Steaming in the impregnating cylinders prior to injection of the antiseptics.
(3) By Steaming in Cylinders separate from impregnating cylinders, followed by a period of air drying and the completion of seasoning and warming of the timber in drying ovens.

Boiling of timber in oil or in chemicals, in the impregnating retort, has the same effect as steaming, which is the second method mentioned above.

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No one will dispute the fact that the better the timber is seasoned, the easier and more satisfactory it can be treated, and if it is warm when introduced into the impregnating cylinder, it will imbibe the oil or chemical more freely and rapidly, and there will be a more thorough absorption and dissemination of the antiseptic into the wood. Mr. Allerton very clearly points out one of the chief causes for poor work when he says, "to get good results from hot oil with cold wood is impossible." The timber should be warm when introduced into the impregnating cylinder, provided it is not given a preliminary steaming or boiling before injection of the antiseptic. The wood should be as warm as the fluid itself, which is dropped upon it, in order to secure the best possible penetration. As there is a great variation in the absorption of the individual pieces in each charge, the injection should be carried to total refusal to insure that the impregnation is as thorough as it is possible to make it.

Means have been discovered by which timber can be given a preliminary treating or seasoning that will produce better results than now obtainable. The method is to steam the timber in cylinders, separate from the impregnating cylinders, and complete the drying in drying ovens and at the same time warm the ties, so that they will be in prime condition to imbibe the antiseptic when placed in the impregnating cylinder. Steaming and impregnating timber in the same cylinder has not been found satisfactory or economical, and the work should be performed in separate cylinders,—the steaming cylinders being much less expensive than the impregnating cylinders. With the necessary adjuncts to the treating cylinders, such as separate steaming cylinders and drying ovens, much valuable time can be saved and the wood can be put in such condition as to produce the best results.

As most of you know, Mr. Allerton is one of the oldest and most highly respected members of this association. He has perhaps had as long and varied experience in timber treating as any member of our association, therefore his statements should carry a great deal of weight and receive very careful consideration.

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SOME FACTS ABOUT
TREATING RAILROAD TIES

BY W. F. GOLTRA

The above is the title of a treatise on tie and timber preservation. The results of many years of experience, study and research in this important subject are embodied in this work. The treatise carries out its suggestive title, in that FACTS are dealt with and NOT THEORIES. The book contains a number of articles that have appeared in the technical press, contributed by Mr. Goltra and others in which the subject matter is considered from all angles.

Part I gives comprehensive descriptions of the various processes of wood preservation that are in present use. Part II is devoted to recent improved methods of treating railroad ties and timbers which are the result of extended research and experience on the part of the author. Part III consists of a discussion of "Mechanical Life" of ties and "Essentials for Effective Work in Timber Treating." Part IV contains a comparison of zinc chloride with creosote for perserving cross ties, Part V "A History of Wood Preservation in Europe and America" and Part VI contains a list of treating plants, showing their location, managing companies, year built, capacity, kinds of woods treated, kinds of materials treated, preservatives used, processes employed, together with a map showing the Forest Regions and locations of all timber treating plants in North America.

BOUND IN THREE PAMPHLETS, 200 PAGES 6x9 INCHES, PAPER COVERS, PRICE $1.50 PER SET

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The Preservation of
Ties, Poles and Timbers
by Antiseptic Treatment

BY
WILLIAM FRANCIS GOLTRA
PRESIDENT, THE W. F. GOLTRA TIE COMPANY
CLEVELAND, OHIO

A Paper Read before the Central Electric Railway Association, November 19th, 1914, at Fort Wayne, Indiana.

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THE PRESERVATION OF TIES, POLES AND TIMBERS BY ANTISEPTIC TREATMENT

BY

WILLIAM FRANCIS GOLTRA

President The W. F. Goltra Tie Company

Cleveland, Ohio

A Paper Read before the Central Electric Railway Association, November 19th, 1914, at Fort Wayne, Indiana.

Mr. President and Gentlemen:—

It was with much pleasure that I accepted the kind invitation from your Chairman of the Program Committee, to prepare a paper on the subject of Preservation of Ties, Poles and Timbers and feel highly complimented by having the privilege of addressing this prominent and flourishing Association. It is my delight to talk about this subject whenever I can get a hearing. It is not so many years ago when it was very difficult to secure any reliable information concerning the various practices for treating material. Operators and practitioners, as a rule, were very reticent and were reluctant in enlighening the uninitiated. Some operators imagined that they alone possessed all of the "secrets" in timber treating and would not freely tell them to the outside world. Such information as could be obtained was often at variance with the truth and people would tell different stories. Some years ago I visited several treating plants in this country for the purpose of acquiring some knowledge as to the different methods then in vogue for treating material. Being General Tie Agent of the New York Central Lines at the time, I was usually received with utmost courtesy. I was generally ushered into the plant and after being politely introduced to the foreman, was shown the roof, the treating cylinders, and a few cars of treated ties and was given the "glad hand" and told to come again.

Only six or eight years ago if you visited a plant you would find the operator conducting his investigations in the utmost secrecy; in other words he thought he had the "world by the tail" and he would tell you one story. If you went to another plant, doing nothing different from what the other fellow was doing—although he too thought he had a hold of that "tail"—he would tell you a different story. It was difficult to reconcile the different stories and at last I asked one of these operators this question: "How does it happen that you operators tell such different stories?" Replying with a broad smile, he said, "Well, Mr. Goltra, there is something about the smell of creosote oil that makes a man a liar." This cleared up the whole field. I am glad to say, however, that the attitude of the oper-

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ators and experts in timber treating is fast changing. There is no reason, so far as I can see, for attempting to keep such methods in secrecy. There are no secrets connected with honest work and proper treatment of ties and timbers when you get down to a logical common sense business basis. There is plenty room for all and the timber treating industry offers wonderful possibilities for expansion and improvement.

The brief time alloted to me will admit of only a brief history of wood preservation in this country and a short description of various methods employed:

HISTORICAL

Before the advent of railways treating of wood in America was primarily for use in construction of locks and canals. Only small quantities of woods were used for structural purposes. The invention of the steam locomotive and railway gave rise to the necessity of protecting the wooden ties from decay. From this period may be reckoned the active progress in wood preservation. The treating of railway ties with a preservative of some kind increased rapidly and very soon the quantity of wood treated in the form of railroad ties exceeded that used for all other purposes. The ratio has been constantly increasing and at the present time about 78 per cent of wood treated is in the form of railroad ties; the remaining 22 per cent consists of piling, poles, paving blocks, construction timbers, cross arms, lumber and miscellaneous articles.

The growth of the timber treating industry in the United States was slow at the beginning. During the period from 1856, when the Vermont Central erected a plant to treat ties with Chloride of Zinc, to 1885, when the Atcheson, Topeka & Santa Fe Railroad erected a plant at Los Vegas, N. Mex., many experiments were made by various railroads and it is estimated that about 50,000 ties were treated during those 29 years. It is not to be supposed that every experiment made in the new field was a success. They were frequently dependent upon men without much experience in this line and, who, to some extent were feeling their way. In the majority of the earlier trials, however, the results were favorable, and railway managers became convinced that much economy could be effected by treating railway ties and timbers.

Prior to 1885 there were only three pressure plants and three or four open tank plants, in existence. From that time the number of pressure plants grew rapidly. At the close of the year of 1890 there were eight plants in operation, which treated 690,000 ties during that year; in 1895 twelve plants, which treated 1,289,000 ties; in 1900, fifteen plants which treated 2,800,000 ties; in 1905 thirty-four plants, which treated 14,890,000 ties; in 1910 seventy-five plants, which treated 30,544,000 ties and at the close of 1913 ninety-two plants in operation and two under construction, treated 36,250,000 ties during that year. The growth of the timber treating industry is truly marvelous and is bound to grow with the diminishing supply of woods suitable for ties without treatment.

STATISTICAL

The quantity of ties required for maintenance and new construction is increasing at a rapid rate with the increasing railway mileage. It is estimated by the author that upwards of 155,000,000 ties were

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purchased during the year 1913, for maintenance and new construction of tracks of all descriptions, as follows:

Companies	Miles Track	Number of Ties Untreated	Treated	Total	Per Cent Treated
Steam Rys.....	377,000	101,750,000	33,250,000	135,000,000	25
Elect. Rys.....	48,000	10,700,000	2,300,000	13,000,000	18
Misc.	20,000	6,300,000	700,000	7,000,000	1
Total.....	445,000	118,750,000	36,250,000	155,000,000	23

The above estimates are based upon the best available information and observations of that branch of railway business and undoubtedly the figures are as near correct as may be possible to obtain at this time. The consumption of railway cross ties has more than trebled since 1885 and more than doubled since 1894, or in twenty years.

Of the ninety-four pressure plants in operation in the United States at the present time, or I should say just before the outbreak of the European war, thirty of them are owned and operated by railroad companies, while sixty-four are owned and operated by commercial companies. As a general rule, those plants owned by railroad companies treat material for their lines exclusively, while the commercial plants handle both railroad and commercial business. Electric railways have not as yet built many plants, although they are quite large consumers of treated ties. Of the thirty plants owned and operated by railroad companies, twenty-nine belong to steam railways and only one to electric railways—the Indianapolis, Columbus & Southern Traction Company's plant, located at Columbus, Ind.

METHODS OF IMPREGNATION

There are two general methods of impregnating woods with antiseptics, namely:

(1) Impregnation by immersion in open tanks or boilers, also in closed tanks or boilers, without pressure. This process is commonly known as the "open Tank or non-Pressure Process."

(2) Impregnation by pneumatic pressure, by means of force pumps and air tight cylinders. The process is commonly known as the "Pressure Process."

OPEN TANK PROCESS

The first method is the simplest and oldest form for applying a preservative. As its name indicates it consists in dipping or steeping the wood in open tanks filled with the preserving fluid. In some cases the wood is boiled in the preservative. Again in other cases the wood is placed in closed cylinders and boiled, but no pressure is applied. It necessarily follows that this is an *absorption*, rather than an *injection* of the preservative fluid. It also follows that the depth of penetration obtained is very shallow, except for particularly open or porous woods, such as sap pine. However, it is only fair to say that some good results have been obtained by this method. "Kyanizing" is an open tank process, employing corrosive sublimate as the preservative, and this process is extensively and successfully used in European countries for impregnating telegraph poles. Manifestly it is a slow process compared with that with which wood is impregnated under pressure and it is only suitable for treating timber in compartively small quantities. Although these are small affairs compared with the modern pressure plants, yet the aggregate quantity of material treated by the open tank process is considerable. On the Pacific Coast there are three or four small iron open tanks in which

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butts of Oregon Fir Poles are boiled in creosote oil. In various parts of the country we find small open tanks, usually second-hand boilers or cylinders, with an opening cut along the upper side and a place to kindle a fire underneath. In these open tanks fence posts and timbers are boiled in the preservative.

PRESSURE PROCESS

The second method of impregnation is the one in general use. In this method the timber is placed in cylinders with closed ends and the preservative is injected into the wood under pressure employing force pumps for this purpose. There are some variations in the operations, but the principle is the same in all of them, namely, the injection of the fluid into the wood by the application of pressure. The various methods or processes may be classed into five groups and described as follows:

Process "A" (Bethell-Burnett-Lowry)

Ties, piling, timbers, poles, paving blocks, or whatever is to be treated, are first "air-seasoned," that is, the material is piled in open air for a period of three to twenty months, to dry out. When sufficiently seasoned it is loaded on small tram cars and run into cylinders six or seven feet in diameter, 100 to 150 feet long, and doors closed. The wood is then submerged in the preserving fluid, heated to a temperature of 170 to 190 degrees Fahr. before admission into the cylinders. The pressure pump is then put into action, forcing more fluid into the cylinder. The operation is continued and maintained until the desired absorption is obtained. The pressure is then released, the surplus fluid drained from the cylinder and a vacuum applied. This last operation is for the purpose of hastening the drying of the material and prevent subsequent dripping when taken out of the cylinders. This completes the treating operation and the material is then withdrawn from the cylinders. The above described method is known as Bethell Process (Pat. 1838) when using creosote oil, Burnett Process (Pat. 1838) when using chloride of zinc, Lowry Process (Pat. 1906) is nothing more than the Bethell Process.

Process "B" (Preliminary Steaming-Vacuum-Pressure)

The material when *green or partially seasoned,* is run into the cylinders and doors closed. Live steam is admitted at such rate as to secure twenty pounds of steam pressure within thirty minutes to fifty minutes. The pressure is maintained from periods varying from one to five hours, depending upon the character of the timber and its condition. A vacuum is then applied and maintained for at least thirty minutes, at the expiration of which time the preservative is admitted into the cylinder without otherwise breaking the vacuum. The wood is then submerged in a preservative fluid, heated to a temperature of 170 to 190 degrees Fahr. before admission into the cylinder. The pressure pump is then put into action. The remainder of the operation is the same as Process "A" above described. This process is quite old and extensively used. It has no patent claimants.

Process "C" (Boulton-Curtis-Isaacs-Buehler)

The material *green or partially seasoned* is run into a cylinder and door closed. The wood is submerged in a preservative, usually creosote oil, and temperature raised to 215 to 225 degrees Fahr., and the boiling maintained for periods ranging from four to eight hours, depending upon the character of the timber and its condition. A vacuum is sometimes applied to assist liberation of saps, in the wood. Pressure pumps are then put into action. The remainder of

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the operation is substantially the same as Process "A" above described. This method is known as Boulton's Process (Pat. 1879), Curtiss & Isaac's (Pat. 1895), Buehler's Process (Pat. 1908). This process is extensively used on the Pacific Coast for treatment of Douglas Fir.

Process "D" (Rueping)

The material must first be "air-seasoned" as in Process "A." It is then run into a cylinder and door closed. An initial air pressure of varying intensity is applied and without lowering this air pressure the cylinder is filled with a preservative, usually creosote oil, and having a temperature of 170 to 190 degrees Fahr. Pressure pump is then put into action and the pressure is raised still higher. The remainder of the operation is substantially the same as in Process "A" above described. This method is known as the Rueping Process (Pat. 1902 and re-issued in 1907). The patentees call it an "empty cell process."

Process "E" (Card)

Creosote oil and zinc chloride (a water solution) have different specific gravities and separate from each other unless kept in agitation. When it is desirable to use a mixture of these two preservatives for the treatment of wood, it is necessary to keep the solution in agitation in the treating cylinder while it is being forced into the wood. A device for this purpose was invented and patented in 1906 by Mr. Card. The emulsion of zinc chloride and creosote oil is made and forced into the wood in one operation. The device consists of a centrifugal pump and pipes that keeps churning the solution in the impregnating cylinder, while under pressure.

GENERAL

Practically all plants in America are equipped to treat by Process "A," the earliest and simplest method of treating timber by the application of pressure. Thirty-one plants are completely equipped to treat by Process "B," while thirteen plants are equipped to treat with Process "C," that is boiling in creosote oil. As boiling in creosote oil performs practically the same functions as steaming, no equipment is required to perform the latter. Of the remaining fifty plants about two-thirds of them are equipped in some fashion for steaming material whenever occasion requires. Seventeen plants are equipped for treating by Process "D" and nine by Process "E."

SPECIES OF WOOD

The varieties of woods treated are numerous and dependent to a large extent upon the kind of timber available in the locality of the treating plant. The principal species are as follows:

Northern Forest. Jack Pine, Spruce, Fir, Birch, Hemlock, Beech, Chestnut, Ash and Tamarack.

Central Forest. Black and Red Oaks, Hickory, Chestnut, Poplar, Cherry, Elm, Maple, Beech, Black Gum, Sycamore and Butternut.

Southern Forest. Long Leaf and Short Leaf Yellow Pine, Loblolly Pine, Black and Red Oaks, Hickory, Black Gum, Red Gum, Elm and Cypress.

Rocky Mountain Forests. Yellow Pine, Spruce, Cottonwood, Douglas Fir, Oaks and Fir.

Pacific Coast Forest. Douglas Fir, Western Red Cedar, Yellow Pines, Spruce, Hemlock, Maples, Birch, Redwood and Larch.

As a rule White Oak is not treated, as it is less abundant and more expensive than other hardwoods. Cedar is not treated as it is fairly durable without treatment and is softer than most woods.

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KIND OF MATERIAL TREATED

The United States Forest Service in colaboration with the American Wood Preservers' Association, collected statistics pertaining to the kind and quantity of material treated in this country during year 1913. A summary of the report follows:

Cross Ties	120,781,248	cu.	ft.	78.7	per cent
Piling	7,957,922	"	"	5.2	" "
Poles	2,500,420	"	"	1.6	" "
Paving Blocks	6,856,293	"	"	4.5	" "
Construction Timber	11,653,628	"	"	7.6	" "
Cross Arms	1,824,719	"	"	1.1	" "
Lumber & Misc	2,039,658	"	"	1.3	" "
	153,613,888	"	"	100.	" "

In 1913 the wood preserving plants treated 147,913 poles. In addition to these an indefinite quantity of poles were given a preservative treatment by less effective methods which add but relatively few years to the service of the poles. Cedar poles constitute about two-thirds of the number treated, and cedar, yellow pine and chestnut poles together amount to nearly 92 per cent of the whole number. From this it is apparent that treatments were applied principally to durable species and that the opportunities which exists for making first-class pole timbers from the less durable woods are not being utilized to any considerable extent. It is natural that pole consumers should first turn their attention to increasing the durability of the woods with which they are familiar. Loblolly Pine of the Southern States, lodegpole pine, Western pine of the Rocky Mountain region and several other woods throughout the country deserve careful consideration, as prospective pole timbers, since most of them take treatment readily and frequently offer consumers the opportunity to use local woods instead of shipping from distant regions at considerable cost.

PRESERVATIVES

The selection of the preservative, although important, is secondary to other factors which influence the durability or life of treated material. Creosote oil is an excellent preservative, but experience has demonstrated that there are other oils or chemicals, which are equally as effective as preservatives and much cheaper. Coal tar creosote is a by-product of a by-product and is not manufactured expressly for preservative purposes. It varies greatly in its chemical composition—coal tar obtained from different coal produces different kinds of creosote oil. The literature on the subject of specifications and methods of analysis of creosote oil is voluminous and bewildering and the specifications are continually changing. The consumers have rather definite ideas as to the quality of creosote desired but unfortunately it has been necessary to base the specifications on the kind of oil available, both abroad and in this country, rather than to make arbitrary standards and expect the manufacturers to meet them. Several additional problems relating to the use of creosote oil as a preservative are pressing for solution. These include the advisability of using various mixtures of creosote oil and other products, such as filtered tar, water gas oil, or combining creosote of different grades; the use of petroleum or water gas tar, wood tar creosote; either alone or in combination with pure coal tar creosote; and the combined use of creosote oil and crude oil, or chloride of zinc. Creosote oil, however, is only one of the many preservatives proposed for the treatment of timber. Various preservatives have, from time to time, been tried and recommended, but the number of

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these which combine efficacy and cheapness is limited. The chief impregnating fluids in use in this country today are chloride of zinc, creosote oil and heavy crude oil. Many other substances have been used for preserving wood, but none of them have given as good results as any one of these three. Up to year 1900, approximately 15,000,000 ties were treated in the United States, of which about 14,500,000 were treated with chloride of zinc and 500,000 with creosote oil. For various reasons, some legitimate and some otherwise, the consumption of creosote oil greatly increased and surpassed that of zinc chloride, to the extent that over twice as many ties were treated with creosote oil as with zinc chloride, during the year 1913. The increasing use of creosote oil has produced a very severe shortage of this material, with a resulting rapid increase in price. About 62 per cent of the creosote oil used by the treating plants in the United States, is imported—chiefly from England and Germany. The European war almost completely shut off this importation and several plants were compelled to close down on account of the scarcity of this commodity. The quantity of creosote oil consumed in the preservation of ties and timbers has increased from 7,700,000 gallons in 1903 to 108,373,000 gallons in 1913.

Chloride of zinc is an efficient and cheap preservative. It has been used longer than any other preservative and the service records, both in Europe and America, attests to it merits as an excellent wood preservative. Like creosote oil the quantity consumed in the preservation of material has increased from 10,500,000 pounds in 1903 to 26,466,000 pounds in 1913. All other preservatives, including crude oil, consumed during year 1913, amounted to 3,885,000 gallons.

Ordinarily ties and timbers when treated with chloride of zinc are treated to "refusal," that is to say, the chemical solution is forced into the wood until it refuses to imbibe any more. The solution is usually made two per cent strong, that is two pounds of zinc chloride salt is dissolved in 100 pounds of water. The average absorption is one and one-half pounds of salt per tie, which at 3½ cents per pound, amounts to between 5 and 6 cents per tie.

Creosote oil is much more expensive, and the price constantly advancing. Ten years ago it was selling at 6 cents a gallon, while today the price is around 10 cents a gallon. Thoroughly seasoned ties, treated to refusal, will absorb an average of 4½ gallons of oil per tie, or 40 cents to 50 cents worth of oil, at current prices. This makes it almost prohibitive to treat ties to "refusal" so we find it is a common practice to inject only a partial or light dose of oil, say 2½ gallons of oil, or less, per tie. Where such practice prevails, it is frequently observed that the ties are only half treated, or superficially covered with black tar oil and as good penetration could have been obtained by open tank process at much less cost. It is poor economy to stop the operation or injection of creosote oil before the receptivity of the timber is exhausted, in order to reduce the cost of treating ties and timbers with this preservative. Far better it would be to use a combination of creosote oil and chloride of zinc and treat the material to refusal.

The combination of creosote oil and chloride of zinc meets with much favor, both in this and European countries. The mixture consists of 12½ per cent creosote and 87½ per cent zinc chloride solution. The cost based on the above prices would be about 11 cents per tie.

WORKMANSHIP

But as stated a little while ago the selection of the preservative is secondary to the other factors influencing the durability of treated material. The quality of work has, in a great many cases, as much to do with the durability of treated material as the pre-

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servative employed. The choice of an antiseptic is only one of the important factors we have to contend with, and it stands next to workmanship. In my opinion, the two most important factors in the treating of material are, (1) the proper seasoning or drying of the material before the injection of the preservative, and, (2) a thorough and full impregnation of the wood with whatever preservative is selected.

In treating timber of any kind it is first necessary to extract the saps, juices and water from the wood before the injection of the fluid. Water logged or green timber with its natural saps and its sap cells in their normal condition will resist the introduction of any fluid, much on the principle that two bodies cannot occupy the same space at the same time. To be able to introduce any solution the natural saps and water in the timber must be in some way removed. The absorption depends, in a large measure, upon the dryness of the wood—the drier the wood the greater will be the absorption and dissemination, consequently the better the treatment. The common practice in this country is to stack the ties in open air for three to twenty months, depending upon the kind and character of the wood, climatic conditions, etc., until the moisture in the timber has evaporated sufficiently for the reception of the preservative. This is a very slow, crude and uncertain method. The seasoning is very unequal and erratic, some pieces retaining more moisture than others and the impregnation is much influenced thereby. Another method is to boil the timber in live steam in the impregnating retorts, just before the injection of the preservative, in order to force out the saps and water in the timber, by heating, loosening and expanding the same into vapor and breaking the cell walls to admit the introduction of the preservative fluid. This method is not altogehtr satisfactory, as the cells are full of vapor and water, which resist the entrance of the preservative fluid. A fair penetration can be obtained by this process with zinc chloride—a water solution—but scarcely any with creosote oil. Several plants in Oregon and Washington employ the method of boiling the ties and timbers in creosote oil, which produces much the same effect on wood as the boiling in live steam. To obtain thorough treatment it is very essential that all saps and water be removed from the wood, so far as possible, before the injection of the fluid and this can be effected quickly and economically by means of steaming the timber immediately upon arrival at the treating plant, then piled in open air for a period of a few months to "season" it, then complete the drying in ovens or kilns. The evaporation of the vapor and water remaining in the wood, after steaming, is more rapid and therefore requires a much shorter period for drying than if it was not given a preliminary steaming. One of the principal advantages derived from this method is the great reduction of stock, necessary to carry on hand for air seasoning. The condition of timber as regards moisture content at time of treating is by far the most important of the many factors influencing the absorption of the preservative and unless this feature is given the utmost attention the results from treatment will hardly ever be satisfactory.

There is another element of destruction besides the decay of wood that shortens the life of ties, which need attention and that is the abrasion caused by rails and spikes. The rail cutting into the face of the tie and the spikes when driven crushing the wood fibre around them hasten the rotting and destruction of the ties, even if they are given an antiseptic treatment. They should be "machined," that is, two surfaces should be planed to receive the rail and four holes bored to receive the spikes, just before the ties are impreg-

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nated. In this way those parts of the ties which are most vulnerable to attack from decay would be protected by a preservative treatment.

CONCLUSIONS AND RECOMMENDATIONS

Many problems in the art of treating wood with antiseptics have yet to be solved and there is much room for improvement. A majority of the timber treating plants in this country, are treating ties and timbers by the same method and in the same manner as was practiced nearly a half century ago. This consists of simply placing the timbers frequently in unfit condition to be treated, in an air tight cylinder, then submerging the wood in a preservative fluid, followed by forcing more liquid into the wood by means of a force pump. Some modifications of this primitive method have been tried and recommended and some improvement has been accomplished, but it has been slow, because in a majority of cases the practitioners confine themselves closely to the methods invented by Sir William Burnett and John Bethell of England, in 1838, and in any departure from these two established methods is made with diffidence. Many years of experience, exhaustive study and close observations of the methods employed in timber treating, both in this and foreign countries, persuades the author to say that the greatest improvement in the present methods employed lies in the direction of a speedier and more efficient method of seasoning ties and timbers, a more thorough conditioning of the wood for receiving the injection of the antiseptic and a greater economy in handling the material in process of treatment, by means of modern equipment and appliances. In conclusion he offers the following summary and recommendations for treating ties, poles, piling and dimension timbers:

(1) The material should be thoroughly "seasoned" or dried by artificial means, consisting of steaming, open air seasoning for a short period and the drying completed in drying kilns.

(2) Ties should be "machined," that is, adzed and bored for rails and spikes just before the injection of the preservative.

(3) The material should be treated to "refusal," with whatever preservative or combination of preservatives the customer demands.

The industry of wood preserving is certain to expand as soon as the more or less experimental period is passed. In using the word "experimental" it is not meant that there is any doubt as to financial results, but there is doubt as to what woods ought to be treated; as to what preservative treatment should be given; the effect of climatic and other conditions; cost of different preservatives and various processes; manner of seasoning and preparing for treatment; supply and price of timber; amount and weight of traffic over a given line; the use of tie plates; weight of rail, etc. These are all important factors in determining the advisability of a preservative treatment.

Your speaker therefore earnestly recommends to the members of this Association, the study and practice of timber preservation, both as an economic proposition and as a check on the rapid depletion of our forests.

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The Preservation of
Ties, Poles and Timbers
by Antiseptic Treatment

BY
WILLIAM FRANCIS GOLTRA
PRESIDENT, THE W. F. GOLTRA TIE COMPANY
CLEVELAND, OHIO

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When you are in need of treated or untreated cross ties, poles, piling, timbers and creosoted paving blocks, write

THE W. F. GOLTRA TIE COMPANY
[illegible]
CLEVELAND, OHIO

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